NOAA Technical Report NOS CS 3

RASTER CHART NAVIGATION SYSTEMS
Results of Questionnaires Soliciting Observations of Professional Mariners and In-House Experts

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January 1998

noaa National Oceanic and Atmospheric Administration

U.S. DEPARTMENT OF COMMERCE
National Ocean Service
Coast Survey Development Laboratory

Office of Coast Survey
National Ocean Service
National Oceanic and Atmospheric Administration
U.S. Department of Commerce

The Office of Coast Survey (CS) is the Nation's only official chartmaker. As the oldest United States scientific organization, dating from 1807, this office has a long history. Today it promotes safe navigation by managing the National Oceanic and Atmospheric Administration's (NOAA) nautical chart and oceanographic data collection and information programs.

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The Marine Chart Division, which collects marine navigational data to construct and maintain nautical charts, Coast Pilots, and related marine products for the United States.

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The Coast Survey Development Laboratory develops new and efficient techniques to accomplish Coast Survey missions and to produce new and improved products and services for the maritime community and other coastal users.

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Executive Summary

The international nautical charting community is actively engaged in creating electronic navigation tools designed to integrate electronic positioning information with nautical chart information. The nautical chart information is being provided in two distinct data types: vector and raster.

Vector systems are sanctioned by the International Maritime Office (IMO) and standardized as Electronic Chart Display and Information Systems (ECDIS). Assembling vector data is time-consuming. Consequently, a full suite of ENCs will not be available for several more years.

Raster chart data (essentially digital copies of paper charts) are easier to produce. Thus there is a large and growing collection of raster charts available for use with systems designed to use raster charts for navigation. Unlike the ECDIS systems, raster navigation systems do not presently have to comply with any recognized standards. The National Ocean Service (NOS) and other hydrographic offices have collaborated in writing a set of Raster Chart Display Systems (RCDS) performance standards which borrow heavily from the ECDIS standards. These standards are needed to insure the safety and operational reliability of raster chart navigation systems.

These hydrographic offices are currently seeking to gain IMO approval of the performance standards. To assess the safety and utility of RCDS, NOS performed an evaluation of raster chart navigation systems already being used at sea by professional mariners. A second questionnaire to test the standards was administered to in-house professionals who are experts from fields related to or supporting nautical charts.

The results of the questionnaire given to professional mariners show that their systems have had a positive impact on all major aspects of navigation and under all navigation conditions. This is based on over 18,400 voyage-situations using raster chart navigation systems. Their responses also revealed some deficiencies but no major problems.

The questionnaire administered to in-house experts revealed that they strongly agree with the requirements of the RCDS performance standard, with no weaknesses uncovered. Their preferences and comments should be beneficial to manufacturers of RCDS.

1. INTRODUCTION

The international nautical charting community is actively engaged in creating electronic navigation tools designed to integrate electronic positioning information with nautical chart information. The nautical chart information is being provided in two distinct data types: vector and raster.

Vector systems are sanctioned by the International Maritime Office (IMO) and standardized as Electronic Chart Display and Information Systems (ECDIS). The vector data files used by ECDIS are called Electronic Navigational Charts (ENC). Developing the ECDIS standards and obtaining final approval from the international community took more than eight years. The vector ENC data used in the ECDIS systems must be collected and attributed. Once collected, the data must still be quality assured. This effort is time-consuming. Consequently, a full suite of ENCs will not be available for several more years.

In the meantime, raster nautical charts (RNC) and the systems that use them have exploded onto the market. At the National Ocean Service (NOS) in the United States, the raster chart product grew out of a new chart production system that uses raster images of the charts as a base upon which the corrections are made. When it is time to print a new edition of the paper chart, the revised raster image is used to make the color-separate negatives for printing. It is a simple matter to also provide the corrected raster image of the chart to the public.

At present, there are far more raster data sets available than vector. The entire suite of U.S. nautical charts is available to the mariner in raster. The United Kingdom, Australia, Canada, and Ireland hydrographic offices also produce RNCs. Brazil announced in November 1997 its intention to do so. Unlike the ECDIS systems, raster chart navigation systems do not presently have to comply with any recognized standards. NOS and other hydrographic offices have concluded that a set of standards for raster chart navigation systems are required. These hydrographic offices have collaborated in writing a set of Raster Chart Display Systems (RCDS) performance standards which borrow heavily from the ECDIS standards. It recognizes the reality that RCDS-compliant systems are a practical tool which is in widespread use and which can add to the safety of navigation in an important way. RCDS* can also serve as an immediate solution while ENC data is being gathered. Standards are needed to insure the safety and operational reliability of RCDS.

These hydrographic offices are currently seeking to gain IHO/IMO approval of the performance standards. To test the standards and assess the safety of RCDS, NOS performed an evaluation of raster chart navigation systems already being used at sea by

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* From this point on, the term RCDS will be used to signify RCDS-compliant raster chart navigation systems.

professional mariners. This observational experiment (as opposed to controlled laboratory or simulator experiments) has several advantages. First, it tests RCDS and the performance standard on actual navigation tasks under real conditions such as varying visibilities, different vessel traffic conditions, and in constrained waterways. Second, it tests RCDS under real bridge conditions with many activities going on simultaneously. Finally it tests RCDS with a variety of mariners of varying ability and who would normally be performing navigational tasks. The same opportunity for thorough at-sea testing of ECDIS was not available when it was being accepted by IMO because there were few systems and little vector data.

The observational experiment performed by NOS was administered as a questionnaire to be completed by professional mariners using raster chart navigation systems. That questionnaire is included as Appendix A to this report. A second questionnaire was administered to other professionals with knowledge or experience related to RCDS. This questionnaire is included as Appendix C. The questionnaires were designed and administered by Dr. Lloyd Huff, Chief, Hydrographic Technology Programs of the NOS Coast Survey Development Laboratory, and Captain Christopher Lawrence, NOAA (ret.), a mariner with substantial experience at sea.

The results from these two questionnaires are presented and analyzed in the next two sections of the report. Conclusions are presented in the final section.

2. QUESTIONNAIRE ADMINISTERED TO PROFESSIONAL MARINERS USING RCDS AT SEA

2.1. Background

An 18-page questionnaire (Appendix A) was sent to 228 professional mariners who have commercial raster chart navigation systems on their vessels. The questionnaire contained questions about the respondent and his or her vessel. The mariners were also asked to rate the impact of their experience with raster chart navigation systems on three aspects of navigation: situational awareness, navigational safety, and personnel stress. This was followed by 14 pages of detailed questions about the respondent's experiences with their raster chart navigation systems, their preferences and practices, and any desired enhancements. The respondents were also given the opportunity to express any concerns they may have about raster chart navigation systems. The complete results are included as Appendix B to this report.

The questionnaires were sent out in February 1997. As of September 30, 1997, 100 responses were received, a return rate of 44%.

2.1.1. Respondent's Vessels. Table 1 shows the class of vessels of the respondents serve on. Slightly more than half were government vessels, followed closely by commercial vessels. There were no responses from recreational vessels.

Vessel Class	Number
Government	53
Commercial	42
Recreational	0
Not Specified	5

Table 1. Class of Vessels

Table 2 further defines the vessels by specific types. Coast Guard and Navy vessels predominated, comprising almost 30% of the respondents. The second largest group, with 16 responses, were the Pilots, who have no permanent vessels.

Type of Vessel	Number
Coast Guard / Navy Vessels	29
Pilots (no vessel)	16
Survey Vessels	14
Research Vessels	12
Passenger Cruise Ships	11
Ocean Tugs / Barges	7
Miscellaneous Vessels	6
River Tugs / Barges	5

Table 2. Vessel types on which respondents serve.

Table 3 shows the characteristics of the respondent's ships (excluding Pilot's). The mean values have been skewed by the size of the eleven passenger vessels. The median values described a vessel slightly smaller than a Coast Guard cutter.

	Mean	Median	Maximum	Minimum
Length (feet)	257.3	180	856	40
Displacement (dwt)	8,415.5	908	70,367	20
Draft (feet)	14.2	12	40	4
Beam (feet)	43.9	34	118	15
Age (years)	29.1	30	55	2

Table 3. Respondent's Vessel's Profile

Table 4 portrays the respondent's ship's complement. This resembles the crew of a typical Coast Guard cutter. Again the averages are skewed by the large crews required by the large passenger vessels.

	Number	Mean	Median	Maximum	Minimum
Officers	82	6.1	6	60	1
Crew	82	98.6	29	949	2
Passengers	23	21.5	216.5	2,634	6

Table 4. Respondent's Ship's Complement

2.1.2. Respondent's Profile. The questionnaire asked respondents about the amount of experience they have had with various navigation aids. Nearly 85% of the respondent's

reported having experience using nautical charts, with an average of over 10 years experience (Appendix B, Table 5). Table 5 shows that 96% report having had experience with radar and GPS systems, and 77% with ARPA. The average experience was 12 years with radar, and over four years with both ARPA and GPS.

Experience (years)	Number	Mean	Median	Maximum	Minimum
Radar	96	12.4	9	40	1
ARPA	77	4.6	5	23	1
GPS	96	4.2	4	15	1

Table 5. Experience with electronic navigation aids.

The respondents have also used their electronic chart display systems extensively. Their use of electronic chart display systems in specific situations (route planning, open water passage, coastal transit, harbor approaches, docking maneuvers, and heavy traffic) is summarized in Table 6.

Estimated Number of Voyages Using Raster Charts	Respondents with Experience	Mean	Median
Route Planning	53	62.3	20
Open Water Passage	46	51.5	12.5
Coastal Transit	60	65.8	20
Harbor Approach	71	88.9	50
Docking maneuver	39	56.9	25
Heavy Traffic	52	68.8	45

Table 6. Estimated number of voyages using raster chart navigation systems.

The respondents have used raster chart navigation systems on **over 18,400 voyage-situations**, an average of 184 per respondent. Table 6 shows that the systems have been used extensively in **all the identified navigational situations**, and for route planning. This establishes a solid background upon which the respondents' answers are based.

The respondents have had the most experience using the raster chart navigation systems for harbor approaches and in heavy traffic. Over 70% reported having used the system for harbor approaches. They averaged almost 89 harbor approaches each. Fewer respondents reported using the raster chart navigation system while docking. Less than 40% reported using the system while docking, but those who did averaged a respectable 57 harbor approaches each.

Question	YES
Q: Are you comfortable operating electronic chart displays?	89
Q: Have you received...training in the operation of electronic chart displays?	33

Table 7. Respondent's relationship with electronic chart displays.

Table 7 shows the respondent's relationship with electronic charts. When asked if they were comfortable operating electronic chart displays, 89% responded in the affirmative, even though only 33% report having had specific training on their system's operation. This high comfort level can probably be attributed in part to the familiarity with the raster image of the chart displayed on the computer display.

2.2. Analysis of Responses.

2.2.1. Impact of Raster Chart Navigation Systems on Navigation. The professional mariners were asked what effect raster chart navigation systems had on three different aspects of navigation: 1) situational awareness, 2) navigational safety, and 3) personnel stress (Tables 8 - 10).

Situational Awareness	Responses	Negative Impact	No Impact	Positive Impact
Open Ocean Passage	95	2.1%	45.3%	**52.6%**
Coastal Transit	95	1.1%	6.3%	**92.6%**
Harbor Approach	97	4.2%	5.3%	**90.7%**
Docking Maneuvers	94	7.4%	**56.4%**	36.2%
Heavy Traffic	96	7.3%	18.8%	**74.0%**
In An Anchorage	96	1.1%	16.7%	**82.3%**

Table 8. Impact of raster chart systems on situational awareness.

Navigational Safety	Responses	Negative Impact	No Impact	Positive Impact
Open Ocean Passage	94	1.1%	48.9%	**50.0%**
Coastal Transit	94	1.1%	7.4%	**91.5%**
Harbor Approach	96	5.2%	1.0%	**93.8%**
Docking Maneuvers	95	11.6%	**49.5%**	39.0%
Heavy Traffic	95	6.3%	21.1%	**72.6%**

Table 9. Impact of raster chart systems on navigational safety.

Personnel Stress	Responses	Negative Impact	No Impact	Positive Impact
Open Ocean Passage	93	0.0%	**53.8%**	46.2%
Coastal Transit	94	0.0%	16.0%	**84.0%**
Harbor Approach	97	3.1%	11.3%	**85.6%**
Docking Maneuvers	94	6.4%	**57.4%**	36.2%
Heavy Traffic	96	6.3%	20.8%	**72.9%**
In An Anchorage	94	1.1%	25.5%	**73.4%**

Table 10. Impact of raster chart systems on personnel stress.

The overwhelming opinion of the 100 respondents is that raster chart navigation systems have a positive impact on navigation. Only when docking did the majority discern the systems had no impact. In open ocean passage the respondents were evenly split between "no impact" "and "positive impact." Otherwise the respondents were almost unanimous in their opinion that when approaching a harbor or in coastal transit, raster systems have a positive impact on navigational safety and situational awareness. This is an impressive testimonial to the value of the functionality found in raster chart navigation systems. Just as significantly, there was no situation or aspect of navigation where respondents felt the systems had a negative impact. When asked:

> *Have you ever experienced a critical situation such as a ship-to-ship encounter or potential grounding that was avoided due to the rapid access to chart information provided by an electronic chart display?*

Thirty-three respondents answered "yes" (Appendix B, Table 9). This represents one-third of all respondents, a significant number.

Here are a few of the critical situations that were avoided:

- ✓ Near grounding - conditions were poor - RCDS helped identify that we were closer to shoal than the OOD/pilot realized. It was at night as well.
- ✓ While positioning aids to navigation in the fog on Bulkhead Bar (Delaware River), RCDS showed vessel getting set into shoal water. Without visual ranges we couldn't see our drift.
- ✓ Inbound Ambrose ship channel. Adverse weather and heavy ship traffic with very poor visibility (fog and rain) was able to maintain correct inbound traffic lane in ship channel, coupled with radar. This would not have been possible without both units. Could have encountered grounding.
- ✓ At least once or twice every trip the electronic chart has been extremely useful; heavy rainstorms, snowstorms, fog or a combination of all.

2.2.2. Monitor Size and Look-Ahead. One of the biggest differences between paper charts and their raster equivalents is size. NOS paper charts normally exceed 3½ feet (well over 1 meter) in one dimension. Raster charts are limited by the size of the computer monitor. The largest monitors on the market today barely exceed 16" (40.6 cm) in the

longest dimension.

Respondents were asked what size monitor they prefer to use with an electronic chart display system. To simplify the decision, only three general choices were provided: small, medium, and large. These were based on the size of the questionnaire page (8½" x 11"). The respondents were asked if they preferred a screen the size of the page (medium), a screen half the size of the page (small), or a screen twice the size of the page (large). The results are as follows (four respondents selected two screen sizes; both choices were counted):

Size of the page:	27.9%
Twice the size of the page:	66.3%
Half the size of the page:	5.8%

The respondents chose the large screen over the medium screen by more than two to one. Only one in twenty chose the small screen. The RCDS performance standard calls for a display of no less than 270mm (10.63 inches) in the shorter dimension, identical to the ECDIS performance standard.

This desire for a large monitor is consistent with the respondents' stated desire for long look-aheads in most navigation situations. Table 11 shows the results when the respondents were asked how far ahead they wish to see in different situations. The table begins with the respondent's desired look-ahead. The median look-ahead was then used to calculate the width of the monitor required to provide that look-ahead at the normal chart scale for that situation. The final column gives the size of that monitor as a diagonal measure.

With the exception of docking maneuvers, the respondents desired a look-ahead distance that, when converted into monitor sizes, resulted in monitors with at least a 17" diagonal viewing-area when the raster chart is displayed at true scale. In fact, three of the navigation situations result in monitor sizes that are not yet economically available in the marketplace. It should be emphasized that these monitor sizes represent the mariner's preferences. The ECDIS/RCDS standard for monitor size is a minimum standard which represents the smallest monitor that will support safe navigation. Users may use larger monitors to fit their needs.

	Answers	Mean (nm)	Median (nm)	Assumed Scale. 1:	Required Screen size (width, using median)	Size Monitor Required (diagonal)
Route Planning	49	111.7	30	-	-	-
Ocean Passage	54	73.4	50	200,000	18.2" (46.2 cm)	**~ 23" (58.4 cm)**
Coastal Transit	65	30.7	15	80,000	13.7" (34.8 cm)	~ 17" (43.2 cm)
Harbor Approach	70	9.2	6	20,000	21.9" (55.6 cm)	**~ 26" (66.0 cm)**
Docking Maneuvers	56	1.6	1	10,000	7.3" (18.5 cm)	~ 9" (22.9 cm)
Heavy Traffic	67	6.1	5	20,000	18.2" (46.2 cm)	**~ 23" (58.4 cm)**

Table 11. Look-Ahead Desired by Respondents; Size Monitor Required.

When asked how the panelists would prefer to have the look-ahead view displayed, the results were divided between having the look-ahead view in a separate window that is always visible, and having the view in a separate, collapsed window that would require the user to switch windows. Less popular was requiring the RCDS to have two monitors, one for the ship's present position and a second for a look-ahead view. The results were as follows (some respondents selected more than one choice).

Look-ahead in a separate window (permanently displayed): 53%
Look-ahead on a separate monitor (requires two monitors): 25%
Look-ahead in a collapsed window (to which the mariner must shift): 53%

	Responses	Less Than 3 Feet	Between 3 and 10 Feet	More Than 10 Feet
Route Planning	67	**82.1%**	14.9%	3.0%
Ocean Passage	73	27.4%	**65.8%**	6.8%
Coastal Transit	85	41.2%	**56.5%**	2.4%
Harbor Approach	91	**52.7%**	42.9%	4.4%
Docking Maneuvers	66	**50.0%**	39.4%	10.6%
Heavy Traffic	84	**52.4%**	45.2%	2.4%

Table 12. Viewing distance from the monitor under various conditions.

The respondents were also asked to estimate their viewing distance from the monitor under various conditions. The results are shown in Table 12. Not surprisingly, the majority

of the time the respondents viewed the system within three feet of the monitor. This most likely corresponds to the viewing distance from the paper chart.

2.2.3. Difficulties with RCDS Display Legibility. Respondents were asked if they had encountered problems with the legibility of raster chart navigation system displays due to outside factors. Overall 61% of the respondents answered yes to one of the four categories. Table 13 shows that conflict with ambient lighting was the biggest difficulty, with 51% of the respondents reporting having had this problem. Approximately one-third of the respondents reported that chart legibility was affected by screen size. Only 6% reported having had a problem with vibration.

Thirty percent of the respondents reported having other problems with legibility. Screen lighting was the problem mentioned most often. Mariners found the screen too bright at night. This can be solved by changing to the color pallette that contains the colors for night operation (see the RCDS Performance Standard, para. 8.1). Respondents also noted having trouble seeing the keyboard at night. This can be solved by using commercially available lighted keyboards. The complete list of 'Other Problems' can be found in Appendix B, Question 8.

Q: Have you had any problems with the RCDS display legibility due to any of the following?	
	Yes
Ambient Lighting	51%
Vibration	6%
Screen Size	35%
Other Problems	30%

Table 13. RCDS display problems.

2.2.4. RCDS As Primary Source of Navigation Decisions. One of the last questions asked was:

> *"If RCDS was made available to you on your ship, would you use it as one of the primary means for making navigational decisions?"*

71% replied "Yes" to this question (if the question was left blank, it was counted as "no"). Table 14 shows the respondents' answers, separated by vessel type.

	Responses	Yes	No
Research Ships	12	6	6
Passenger Cruise Ships	11	7	4
Survey Ships	14	10	4
Coast Guard/Navy Ships	29	24	4
Pilots	16	10	6
Ocean Tug/Barges	7	6	1
River Tug/Barges	5	3	2
Miscellaneous	6	5	1
Total	100	**71**	**29**

Table 14. Would you use an RCDS as a primary means for making navigational decisions?

With the exception of research vessel respondents, a large majority indicated they would use the RCDS as a primary source for making navigational decisions.

2.2.5. Respondent's Concerns. The final question on the questionnaire gave respondents a chance to record any concerns they have about raster chart navigation systems. The complete list of comments are included in Appendix B, Question 49. Many of their concerns stem from the type of misgivings that result whenever users are presented with new technology. Comments such as, 'RCDS can lure the mariner into a false sense of security,' and 'RCDS does not replace looking out the window' are real concerns that are best addressed through training programs. This need for training was recognized by other respondents who recommended that RCDS users should be required to pass a test, and RCDS units, users, and installers should be certified.

Other concerns on the list can also be rectified through training. These include using RCDS at inappropriate scales, how to use (or when to use) RCDS for docking, and the realization that DGPS accuracy can sometimes exceed the accuracy of the chart.

Some respondents mentioned the need for timely corrections to the raster charts used by RCDS. The importance of this issue is reflected in the RCDS performance standard which requires that an updating system be part of the raster chart suite used in an RCDS.

Another group of concerns center around the design of RCDS. A river pilot advised that river navigation requires a different design than navigation systems used on open water vessels. Another believes that RCDS equipment should be ruggedized for shipboard use. These, and other suggestions, should be taken into consideration by RCDS manufacturers.

2.3. Summary

Raster chart navigation systems have been criticized for having a number of limitations in their use. Some of the perceived limitations could be hazardous to navigation. This survey, based on over 18,400 voyage-situations, establishes that the 100 professional mariners who responded to this questionnaire found the use of raster chart navigation systems **increased** navigational safety in most situations. In cases where navigational safety was not increased, they found using the raster system had no impact on navigation. **In addition, one-third of the respondents reported experiencing a critical situation that was avoided due to the rapid access to chart information provided by raster chart navigation systems.** In the end, seventy-one of the one-hundred respondents concluded they would use an RCDS as a primary source for making navigational decisions.

3. QUESTIONNAIRE ADMINISTERED TO IN-HOUSE EXPERTS

3.1. Background

The questionnaire in Appendix C was administered on January 22, 1997. There were 38 panelists from 6 marine specialties (see Table 14); all panelists were NOAA employees (NOAA Corp officers and civilians).

Marine Specialty	Number
Master Mariner	6
Maritime Administrator	2
Cartographer	18
Hydrographer	5
Marine Technologist	1
Other	6
Total	**38**

Table 15. Marine Specialties.

For analytic purposes, the single Marine Technologist was combined with the "Other" specialty, thus reducing the number of marine specialties to five. Besides the respondent's marine specialty, there were no questions about the panelists' background or training.

Gathering the opinions of experts from fields related to or supporting marine navigation is an important addition to the experiences of mariners collected in the other questionnaire. These experts add breadth to the issue. For example, cartographers understand the relationships between the features they chart and can foresee the consequences of only presenting a portion of the chart on the monitor. Hydrographers, on the other hand, are aware of the extent to which chart clutter can obscure important bottom features. Many of the master mariners have used raster navigation systems at sea and have the added advantage of experience in offices that process and apply marine data to nautical charts.

The questionnaire consisted of 73 questions (questions 15 and 74 were combined with other questions before the questionnaire was administered). The questions were presented as statements describing functionality contained in the draft RCDS performance standard or functionality that exceeded the standard and could be added to an RCDS. The inclusion of statements describing additional functionality was not intended to suggest that the functionality is a candidate for future inclusion in the RCDS standard.

The panelists were asked to read the statements and register their level of agreement by placing a number from 10 (strongly agree) to 0 (strongly disagree) in the blank. Because some questions contained more than one statement, there were a total of 84 responses. The full questionnaire is included in Appendix C along with the scores for each question.

3.2. Analysis of Responses

The statements in the questionnaire were deliberately worded to present an idealized raster chart navigation system and it's functionality in a positive manner (with a few exceptions). Thus, high agreement scores can generally be interpreted as support for the RCDS performance standards and the additional functionality likely to be included in commercial RCDS.

Though the average measure of agreement (or "score") for the 84 responses ranged from a high of 9.8 to a low of 2.7, more than half (56%) of the scores were clustered between 8.9 and 7.7. Only 12% of the scores were below 6.0. The median score was 8.3, as was the mode (the mean was 7.9). If one considers scores below 4.0 to represent disagreement, scores between 4.0 and 6.0 to represent a neutral position, and scores above 6.0 to represent agreement, then we have:

Agree:	88.1%
Neutral:	7.1%
Disagree:	4.8%

There can be no doubt that the **in-house experts using their additional knowledge strongly support the draft RCDS standard, and enhancements.**

Because the weighted mean scores were consistently high, the ability to discern patterns when analyzing opinions about the RCDS standards has been hampered. Preferences are subtle, often varying more among the marine specialties than among responses to the various statements. A case in point, question 10 states,

> *"Upon start up, the RCDS should first present the STANDARD display of the largest scale applicable chart that includes the ship's position."*

While the weighted mean score for this statement was 8.3 (the same as the median score) the scores among the marine specialties varied from a low of 6.0 for the master mariners to a high of 9.5 for the maritime administrators.

It should be noted, however, that other than the six master mariners, most of the respondents of this questionnaire have had no experience using raster charting systems. Thus this questionnaire did not deal with attitudes towards, or experience with, raster chart navigation systems. The questions merely sought to measure nautical charting experts' perception of the RCDS performance standards and additional functionality, although some questions were designed to measure preferences for system enhancements.

3.2.1. Monitor Sizes and Resolution. One enhancement to the minimum RCDS performance standard is screen size. The ECDIS/RCDS standard requires a monitor whose image area is no less than 270 mm (10.63 in.) in the smaller dimension. The in-house experts were asked to evaluate monitor sizes for use with an RCDS. They were presented with eight monitor sizes in one inch (25.4 mm) increments from a diagonal

measure of nine inches (229 mm) through sixteen inches (406 mm). The respondents were asked to rate the acceptability of each size as the minimum RCDS standard monitor. To assist the panelists evaluate the screen sizes, nautical charts were cut to the listed screen sizes and were posted for all to see. Table 16 presents the in-house expert's preferences broken out by marine specialty. The combined score is shown in the column on the far right. The scores can range from 0 to 10 with 10 indicating the highest preference for that monitor size.

Diagonal Screen Size inches	mm	Master Mariners	Maritime Admin.	Cartog.	Hydrog.	Others	Total
9"	(229)	4.3	6.5	2.9	1.6	0.6	**2.7**
10"	(254)	4.2	6.5	2.7	1.6	1.2	**2.7**
11"	(279)	5.0	7.0	3.6	3.2	3.6	**3.9**
12"	(305)	5.6	7.5	3.9	5.4	5.4	**4.8**
13"	(330)	5.8	6.5	4.9	6.0	5.6	**5.4**
14"	(356)	6.8	7.0	6.3	7.4	6.7	**6.6**
15"	(381)	7.2	7.0	6.5	8.4	3.7	**6.4**
16"	(406)	8.8	6.5	7.3	8.0	4.0	**6.9**

Table 16. Minimum monitor size preferences.

The master mariners and cartographers preferred a 16" monitor minimum, the marine administrators preferred 12" minimum, hydrographers chose a 15" minimum, and the remainder preferred a 14" minimum. Overall, the acceptability scores rose as the screen sizes increased, with the 16" minimum having the highest acceptability.

Respondents were also asked whether the RCDS should be able to comply with the IHO ECDIS screen resolution of 864 pixels across the smaller dimension of the screen (Question #13). This received an weighted mean score of 7.8. In retrospect, the question required more information than the respondents could be expected to have. Screen resolution is generally measured by dots (pixels) per inch. To convert the full-screen single-dimension 864 pixels to dots per inch, the respondent needed to know how to convert diagonal screen sizes to their corresponding height and width dimensions. That information was not provided. One respondent astutely wrote next to the question, "I have no opinion on resolution value. Legibility should be the criterion."

3.2.2. Chart Scale and Zooming Functionality. Question 6 asked if there should be two display modes. It read:

> *"The RCDS should have two display modes, as follows: STANDARD Display, display of the raster chart at the scale of the original paper chart. VARIABLE Display, display of the raster chart at a larger or smaller scale than that of the original paper chart."*

The scores ranged from 7.1 for "others" to 9.0 for master mariners, with a weighted mean of 7.7. An examination of the written comments offered by respondents shows a concern for displaying the raster chart at a scale larger (and smaller) than true chart scale.

Question 8 was more specific. It read,

> *"The RCDS VARIABLE display should be: (a) limited to scale variations between one-half and twice the scale of the original chart, (b) limited to scale variations between one-quarter and four times the scale of the original chart, or (c) only limited to scale variations based on legibility."*

Table 17 presents the results of question 8. The answers are based on a scoring range from 0 to 10, with 10 representing the highest level of agreement with the statement.

Statement	Master Mariner	Marine Admin.	Cartog.	Hydrog.	Other	Total
(a) ½ - 2x	3.3	6.5	5.2	9.4	2.7	**5.1**
(b) ¼ - 4x	4.2	7.0	4.3	6.2	3.0	**4.4**
(c) limited by legibility	8.2	6.5	5.4	3.6	6.0	**5.8**

Table 17. Limiting zoom capability

Statements (a) and (b) are similar, differing only in the zoom limit. Neither statement received much agreement, but (a) had a higher weighted mean score than (b). Statement (c) limits the scale variations to the limits of legibility. It had a higher score than (a) or (b), especially among the master mariners, but the weighted mean score for (c) was still only 5.8. It appears many respondents saw no need for restricting the amount of zoom available to mariners.

Question 9 stated,

> *"The RCDS VARIABLE display should include an indication of actual display scale when information is displayed at a LARGER or SMALLER scale than the original paper chart."*

The weighted mean scores for this statement ranged from 9.6 and 9.5 for hydrographers and marine administrators respectively, to 7.0 for master mariners. The total weighted mean was 8.3. Hydrographers and cartographers, professions that are acutely aware of the relationship between scale and accuracy, were among the most concerned about using charts at scales other than the published scale. One cartographer wrote, "Larger scale displays of chart area should include [a] warning of data accuracy and reliability." Another cartographer noted, "Scale tends to be misunderstood by most users--the system should prevent use beyond the implied data accuracy."

Questions 10 through 12 also pertain to chart scale. All received weighted mean scores of between 8.0 and 8.3, which is interpreted to mean the respondents would like the RCDS to indicate the current scale of the chart on the display when the chart is zoomed in or out.

The respondents also want the RCDS to display the largest scale chart available when the system first comes up, and they would like the system to indicate when there are charts of other scales available to the user.

3.2.3. Periodic Chart Updates. Paper nautical charts used for navigation must be kept up-to-date from notice to mariner publications. The RCDS performance standard requires raster charts to be updated as well. The questionnaire included several questions about updates.

Question 29 stated:

> *"The RCDS must be capable of accepting official updates to the raster chart data set. These updates should be automatically applied to the previously resident official raster chart data."*

This statement had a strong weighted mean score of 9.1.

Question 38 stated:

> *"The contents of RCDS raster chart data set with its updates should be adequate and up-to-date for the intended voyage, as required by V/20 of SOLAS."*

This statement received an even higher score of 9.8.

There is good agreement concerning the importance of maintaining the raster charts. There was less agreement over how they should be maintained. Question 30 suggested the RCDS must be able to accept manual updates to the raster chart data set. It received a weighted mean score of only 7.6, with only the maritime administrators giving it a score higher than 8.0. A cartographer responded, "Absolutely not." A hydrographer exclaimed, "Manual updates should not be allowed." Allowing manual updates to the raster chart means allowing mariners to delete data from the raster chart, and someone might delete a critical feature by accident. When presented with question 39, which states,

> *"The RCDS MUST NOT provide a means to alter the contents of the raster chart data set."*

the respondents gave it a score of 8.3. Question 29 stated:

> *"The RCDS must be capable of accepting official updates to the raster chart data set. These updates should be automatically applied to the previously resident official raster chart data set."*

This received a weighted mean score of 9.1. It appears the respondents prefer a purely automatic system of updates to one that allows some updates to be applied manually.

3.2.4. Alarms. Raster chart navigation systems have an advantage over paper charts in that they can combine the ship's current position from it's positioning system with user-defined limits and generate alarms when certain conditions are met (or not met). For example, the system can return an alarm if the ship's position deviates too far from the planned route, or if the ship crosses a user-defined danger limit. While this functionality exceeds that of a paper chart, the draft RCDS performance standard includes requirements for alarms.

The in-house experts were asked about the desirability of alarms for specific situations. Questions 44, 45, and 52 suggested the RCDS must provide an indicator if a planned route crosses a mariner-entered safety line, if a planned route crosses a boundary of a geographical area which the mariner has highlighted to be avoided, and when the specified limit of deviation from the planned route is exceeded. Their weighted mean scores were 8.3, 8.6, and 8.3 respectively.

Other questions suggested providing an alarm when the ship approaches a waypoint (score: 6.8), sounding an alarm if the RCDS is not on the same geodetic datum as the electronic positioning device (score: 8.6), and sounding an alarm if the position-fixing system is lost (score: 9.5). The master mariners consistently had the lowest scores among the marine specialties.

Judging by their scores, the respondents agree on the usefulness of alarms for many situations.

3.3. Summary

Despite their varied backgrounds, the 38 respondents of this questionnaire showed strong overall agreement with the statements that reflected the RCDS performance standard. The respondents also provided valuable direction for additional functionality and enhancements. There was general agreement that larger monitors are preferable. The respondents do not favor restricting the zoom factors available to mariners, but they did express concern for using raster charts at inappropriate scales for navigation. It was suggested that the scale of the chart, as displayed, be prominently exhibited. The respondents also showed strong support for including alarms in RCDS to alert the mariner to unsafe conditions.

4. COMPARISON OF QUESTIONNAIRES

The two questionnaires were administered to two different groups of professionals with different objectives. The first was given to professional mariners who have used raster chart systems on pilot's vessels for navigation. Their questionnaire was designed to identify deficiencies in current raster chart systems, which have many of the features required in the RCDS performance standards. The second questionnaire was given to professionals who are responsible for collecting nautical data and applying it to nautical charts. This questionnaire was a means of presenting the RCDS performance standard and potential enhancements to commercial RCDS. By exposing the RCDS performance standards to specialists in a broad range of fields, any flaws or inconsistencies in the standards would be revealed.

No major problems were detected with the use of raster chart navigation systems for navigation, or with the RCDS performance standard.

5. CONCLUSION

Professional mariners with over 18,400 voyage-situations using raster chart navigation systems report these systems have had a positive impact on all major aspects of navigation.

The 100 respondents were asked to evaluate the impact of raster chart navigation systems in three facets of navigation and six different situations (one facet had only five situations). The majority of respondents reported the raster systems had a positive impact in 12 of the 17 cases. In another case, 50% reported the impact was positive. In the remaining four cases, the majority reported raster chart systems had neither a positive nor negative impact. In none of the 17 cases did the majority feel raster chart navigation systems had a negative impact on navigation (in fact the negative impact numbers are very low–ranging from a high of 11.6% who reported a negative impact down to a low of 0%). In addition, 33% of the respondents reported being in a crisis situation that was avoided due to the presence of an RCDS.

While the respondents reported no major problems using their raster chart navigation systems for navigation, they noted a few areas of concern. Most of these concerns can be resolved through a training program or through design changes by RCDS providers.

The in-house expert's responses show a high degree of agreement with the different requirements of the RCDS performance standard. They found no major deficiencies. Their preferences and comments should be beneficial to value-added providers of RCDS.

The reader's attention is specifically directed to Appendix B, Page 43, where specific critical situations avoided by the use of RCDS are described by mariners involved in these tests.

APPENDIX A

Questionnaire Distributed to Mariners Using RCDS at Sea

The Office of Coast Survey appreciates your participation in this collection of professional operators' reactions to Raster Chart Display Systems (RCDS). This is an important step toward setting regulatory standards for RCDS. **All responses will be kept in confidence**: neither you, nor your ship, nor your company will be associated with any comments or opinions on the basis of this questionnaire, unless you and your company give their explicit permission for us to do so.

If you are a pilot, please start this questionnaire on page 3.

SHIP INFORMATION

Length ____ Displacement _____ Draft___

Beam ____ Age___

Type___ Recreation ___ Commercial___ Government___

Normal complement

officers _____

crew _____

passengers _____

Usual route or area of operation _____

_____

Briefly describe the primary function of the vessel._____

_____

Does the vessel have an electronic chart display as part of its standard suite of navigation equipment?
Circle Yes(Y) or No(N) ___Y___N___ If yes, please specify type of electronic chart display.

_____

_____

Does the vessel have a **Differential GPS** as part of its standard suite of navigation equipment?
Circle Yes(Y) or No(N) _Y___N_
Have you observed a pilot using a portable electronic chart display on the bridge of the vessel?
Circle Yes(Y) or No(N) _Y___N___ If yes, please specify type of electronic chart display.

_____

_____

OPERATOR INFORMATION

Marine Education/Training_____

_____

License(s)_____

_____

Years of experience with bridge/navigation functions and tasks:

(a) helmsman _____

(b) navigation/chart work _____

(c) officer of the watch _____

(d) captain/master of a vessel _____

(e) pilot _____

(f) other, please specify. _____

_____

Years of experience operating electronic navigation aids:

(a) radar ____

(b) ARPA ____

(c) Global Positioning System (GPS) ____

Rank your computer skills as 1, 2, 3, 4, or 5, using 1 for LOW Skill Level and increasing to 5 for HIGH Skill Level. ____

Please list the different electronic chart display hardware and software that you have operated or been trained to operate.

_____

_____

_____

Estimated number of voyages, if any, using electronic chart displays, in which the following apply.

route planning ____

open water passage ____

coastal transit ____

harbor approach ____

docking maneuver ____

heavy traffic ____

Have you ever encountered a situation where the charted location of a geographic/hydrographic feature is incorrect on a paper chart? Circle Yes(Y) or No(N)
Y N

if yes, please comment._____

_____

_____

Are you comfortable operating electronic chart displays?
Circle Yes(Y) or No(N) Y N

Have you received specific training in the operation of electronic chart displays?
Circle Yes(Y) or No(N) Y N

Have you ever experienced a critical situation such as a ship-to-ship encounter or potential grounding that was avoided due to the rapid access to chart information provided by an electronic chart display? Circle Yes(Y) or No(N) Y N

if yes, please comment._____

_____

_____

What effect do you think electronic chart displays have on the quality of the **SITUATIONAL AWARENESS** under each of these scenarios?

	negative impact	no impact	positive impact
open ocean passage	___	___	___
coastal transit	___	___	___
harbor approach	___	___	___
docking maneuvers	___	___	___
heavy traffic	___	___	___
in an anchorage	___	___	___

What effect do you think electronic chart displays have on the quality of the **NAVIGATIONAL SAFETY** under each of these scenarios?

	negative impact	no impact	positive impact
open ocean passage	___	___	___
coastal transit	___	___	___
harbor approach	___	___	___
docking maneuvers	___	___	___
heavy traffic	___	___	___

What effect do you think electronic chart displays have on the level of **PERSONNEL STRESS** under each of these scenarios?

	negative impact	no impact	positive impact
open ocean passage	___	___	___
coastal transit	___	___	___
harbor approach	___	___	___
docking maneuvers	___	___	___
heavy traffic	___	___	___
in an anchorage	___	___	___

Note: If you think the following questions do not apply to your vessel or requires knowledge beyond your experience, please mark that question **N/A**.

(1) How much time do you normally spend using an electronic chart display to perform route planning activities for a typical voyage? _____ hours

(2) Please estimate from what **VIEWING DISTANCE** you will usually look at the RCDS under each of the following scenarios:

	< 3 ft	**> 3 < 10 ft**	**>10 ft**
route planning	____	_____	____
open ocean passage	____	_____	____
coastal transit	____	_____	____
harbor approach	____	_____	____
docking maneuvers	____	_____	____
heavy traffic	____	_____	____

(3) The minimum allowable size of the **RCDS DISPLAY SCREEN** is yet to be determined. Please indicate your preference concerning the minimum requirement for the size of the chart presentation area on the RCDS display?

(a) about the size of this paper Y N

(b) about twice the size of this sheet of paper Y N

(c) about one-half the size of this sheet of paper Y N

(4) Do you see any benefit in being able to control the size of the following RCDS symbols? Circle Yes(Y) or No(N)

own ship: Y N

intended track: Y N

past track: Y N

waypoint: Y N

time marks: Y N

vector for course & speed made good: Y N

fixes: Y N

(5) Is it beneficial to have the capability in RCDS to display your own ship at the scale of the display under the following scenarios? Circle Yes(Y) or No(N)

route planning: Y N

open ocean passage: Y N

coastal transit Y N

harbor approach: Y N

docking maneuvers: Y N

heavy traffic: Y N

(6) Is it beneficial that the RCDS, including symbols, look as much as possible like a paper chart under the following scenarios? Circle Yes(Y) or No(N)

route planning: Y N

open ocean passage: Y N

coastal transit: Y N

harbor approach: Y N

docking maneuvers: Y N

heavy traffic: Y N

in an anchorage: Y N

(7) Is it beneficial for RCDS users to have the ability to change color of the following RCDS symbols. Circle Yes(Y) or No(N)

own ship? Y N

intended track? Y N

waypoints? Y N

past track? Y N

time marks? Y N

vector for course & speed made good? Y N

fixes? Y N

(8) Have you had any problems with the RCDS display legibility due to any of the following reasons: Circle Yes(Y) or No(N)

ambient lighting? Y N

vibration? Y N

Other problems? Y N

If other, please comment_____

_____

_____

_____

(9) Would it be beneficial if RCDS included the capability for **MARINER ENTERED DATA**, such as defining groups of lines, boundaries, or areas of particular interest for a planned voyage? Circle Yes(Y) or No(N) Y N

(10) Would it be beneficial to have the capability to review present and previous updates to **MARINER ENTERED DATA** displayed on RCDS? Circle Yes(Y) or No(N) Y N

(11) What information would be beneficial concerning the **MARINER ENTERED DATA** (date/time, basis of information, person who entered it, etc.)?

_____

_____

_____

(12) What voyage or ship specific **MARINER ENTERED DATA** would be beneficial if you could add it into the RCDS database? Please give examples of features that you would define and how you would use them.

_____

_____

_____

_____

_____

_____

(13) What method of notification and control would benefit you when dealing with the processing of **OFFICIAL GOVERNMENT AUTHORIZED** updates, corrections, cautionary notes, or Notice to Mariners on RCDS? Circle Yes(Y) or No(N) based on whether or not a method of notification would be beneficial to you.

Pull down from World Wide Web (Internet) Y N

Inmarsat communications Y N

Diskette by over night courier Y N

Diskette by national postal service Y N

(14) Please circle Yes(Y) or No(N) to indicate if the feature is beneficial or not to you during **ROUTE PLANNING**.

a. user defined areas of avoidance Y N

b. way points Y N

c. user defined lines not to cross Y N

d. range and bearing to user selected chart features Y N

e. planned routes Y N

f. alternate route Y N

g. indications of depth and height units Y N

h. availability of larger scale chart Y N

i. availability of smaller scale chart Y N

j. contents of cautionary notes Y N

k. indication of scale and distance Y N

l. chart scale boundaries Y N

n. edition date of the Raster Nautical Chart Y N

n. geodetic datum Y N

o. magnetic variation Y N

p. latest update to displayed raster chart Y N

(15) Please circle Yes(Y) or No(N) to indicate if the feature is beneficial or not to you during **CRUISE MONITORING.**

a. user defined areas of avoidance Y N

b. way points Y N

c. user defined lines not to cross Y N

d. range and bearing to user selected chart features Y N

e. planned routes Y N

f. alternate route Y N

g. indications of depth and height units Y N

h. availability of larger scale chart Y N

i. availability of smaller scale chart Y N

j. contents of cautionary notes Y N

k. indication of scale and distance Y N

l. chart scale boundaries Y N

n. edition date of the Raster Nautical Chart Y N

n. geodetic datum Y N

o. magnetic variation Y N

p. latest update to displayed raster chart Y N

(16) Suppose you could select features that would either always be presented on the screen or could readily be called up. Circle Yes(Y) or No(N) as you would choose to have that feature available for **DISPLAY**.

a. user defined areas of avoidance Y N

b. way points Y N

c. user defined lines not to cross Y N

d. range and bearing to user selected chart features Y N

e. planned routes Y N

f. alternate route Y N

g. indications of depth and height units Y N

h. availability of larger scale chart Y N

i. availability of smaller scale chart Y N

j. contents of cautionary notes Y N

k. indication of scale and distance Y N

l. chart scale boundaries Y N

n. edition date of the Raster Nautical Chart Y N

n. geodetic datum Y N

o. magnetic variation Y N

p. latest update to displayed raster chart Y N

(17) In one look at the RCDS display, how far ahead (distance or time) do you need to look ahead in the following scenarios?

	DISTANCE	TIME
route planning	_____	_____
open ocean passage	_____	_____
coastal transit	_____	_____
harbor approach	_____	_____
docking maneuvers	_____	_____
heavy traffic	_____	_____

(18) RCDS may provide **OPTIONAL RADAR** information in the form of full radar video, ARPA targets, or both. Circle Yes(Y) or No(N) to indicate if you feel **FULL RADAR VIDEO**, **ARPA TARGETS**, **BOTH** (circle both Y's), or **NEITHER** (circle both N's) would be beneficial or not on the RCDS display for each of the following purposes:

	FULL RADAR	**ARPA TARGETS**
for assessing the overall navigation situation.	Y N	Y N
as an aid in interpreting radar.	Y N	Y N
for evaluating options open to target vessels.	Y N	Y N
for grounding/collision avoidance.	Y N	Y N

(19) Under what circumstances, such as heavy traffic, nighttime, navigating without Differential GPS, or visibility limited by weather conditions, would you choose to activate the **OPTIONAL RADAR**? _____

_____

_____

(20) Would your preferred color scheme for optional radar presentation on RCDS be different for day and night?
Circle Yes(Y) or No(N) Y N

(21) Is it more beneficial to have the radar image be: (a) on top of both the route information and the chart (TOP), (b) under the route information, but on top of the chart (BETWEEN) or (c) under both the route information and the chart (BOTTOM)? Please circle Yes(Y) or No(N) to indicate your preference.

(a) TOP: Y N

(b) BETWEEN: Y N

(c) BOTTOM: Y N

(22) RCDS may allow different display MODES of MOTION. One possible mode would be TRUE MOTION where the ship moves across the chart. Another possible mode would be RELATIVE MOTION where the chart scrolls to always keep the ship in the same place on the display. Please circle Yes(Y) or No(N) to indicate if you would use TRUE MOTION or RELATIVE MOTION or EITHER (circle both Y's), for each of the following.

	TRUE MOTION	**RELATIVE MOTION**
open ocean passage	Y N	Y N
coastal transit	Y N	Y N
harbor approach	Y N	Y N
docking maneuvers	Y N	Y N
heavy traffic	Y N	Y N

(23) In RCDS, using true motion mode, you may be able to control the distance from the ship's symbol to display boundary at which the RCDS redraws the chart display. Would this capability be beneficial to you? Circle Yes(Y) or No(N) Y N

(24) In RCDS, using true motion mode or relative motion mode, you may be able to "suspend" the automatic redrawing action? Would this capability be beneficial to you? Circle Yes(Y) or No(N) Y N

(25) In RCDS, using relative motion mode, you may be able to place the ship's symbol in the middle of the screen when the screen is redrawn, or place the ship's symbol off toward the side to give you more view of the route ahead? Circle Yes(Y) or No(N) to indicate if you would use the following:

Middle Y N

Off-center Y N

(26) RCDS may allow north-up or course-up **CHART ORIENTATIONS** for cruise monitoring. Circle one column, or the other, to indicate your probable use of **COURSE-UP** or **NORTH-UP** chart orientation under each of the following circumstances.

	COURSE-UP	**NORTH-UP**
open ocean passage	____	____
coastal transit	____	____
harbor approach	____	____
docking maneuvers	____	____
heavy traffic	____	____

(27) If the electronic positioning sensors fail, would it be beneficial for RCDS to calculate and display the error bounds on positions based on dead reckoning (for example, speedlog and gyro input)? Circle Yes(Y) or No(N) ___Y N___

(28) Would it be beneficial for you to be able to manually enter the ship's position information?
Circle Yes(Y) or No(N) ___Y N___

If yes, please comment on the circumstances when this would be beneficial. _____

_____

_____

_____

(29) RCDS may provide a **WARNING** when the RCDS detects a dangerous situation. Please circle Yes(Y) or No(N) to indicate if you prefer **AUDIBLE WARNING**, **VISUAL WARNING**, **BOTH** (circle both Y's), or **NEITHER** (circle both N's), for each of the following.

	AUDIBLE WARNING	**VISUAL WARNING**
Excessive cross-track error	Y N	Y N
Crossing mariner entered line	Y N	Y N
Possibility of entering avoidance area	Y N	Y N
Information overscale	Y N	Y N
Larger scale RNC available	Y N	Y N
Different reference system for chart and positioning system	Y N	Y N
Deviation from route	Y N	Y N
Failure of Positioning system	Y N	Y N
Loss of Differential correctors for GPS	Y N	Y N
Approach to critical waypoint	Y N	Y N
System fails self-test function	Y N	Y N
Malfunction of RCDS	Y N	Y N

(30) Would it be beneficial for the RCDS user to be able to suppress visual and audible warnings in RCDS?
Circle Yes(Y) or No(N) Y N

If yes, please describe the circumstances that you would suppress the visual and or audible warnings._____

_____

_____

(31) Would it be beneficial to navigational safety if the RCDS visual and audible warnings were standardized for all RCDS manufacturers? Circle Yes(Y) or No(N)
Y N

(32) What data should be included in the electronic log record that RCDS keeps of the ship's voyage? Circle Yes(Y) or No(N) for the different information and, if necessary, add in other information that you feel would be beneficial to record.

ship position Y N

course and speed Y N

ARPA targets Y N

other: _____

(33) How much data should RCDS be required to keep, and how frequently should it be recorded under the following scenarios?

	days	**minutes**	**recording interval**
open ocean passage	___	___	___
coastal transit	___	___	___
harbor approach	___	___	___
docking maneuvers	___	___	___
heavy traffic	___	___	___

(34) Do you feel that playback of RCDS voyage records, is likely to be beneficial in training ship operators?
Circle Yes(Y) or No(N) Y N

(35) Would you prefer to have a separate window, or separate screen for look-ahead and route editing, so that you can continue to track the ship's current position visually with simultaneous look ahead. Or would you prefer to switch between look-ahead and present location by a single action? Please circle Yes(Y) or No(N) to indicate your **DISPLAY PREFERENCE** for look-ahead and route editing.

(a) separate window Y N

(b) separate display screen Y N

(c) one screen, on one window, with switching Y N

(36) Is automatic boundary and area detection/warning a necessity if the RCDS allows the user to have the ship off the screen for look-ahead or route editing?
Circle Yes(Y) or No(N) Y N

(37) What additional beneficial navigation tools and capabilities would you like to see built in to RCDS? _____

_____

_____

(38) There are several possible methods that RCDS could use to present alphanumeric information such as **CHART NOTES**. Circle Yes(Y) or No(N) to indicate if you feel one of these options would be beneficial or not.

(a) pop-up windows on the main RCDS screen Y N

(b) dedicated area on the main RCDS screen Y N

(c) separate (smaller) display screen Y N

(39) What means do you prefer for **CONTROLLING POP-UP WINDOWS** and other **RCDS INTERFACES**? Please mark each one as acceptable or not acceptable.

	acceptable	**not acceptable**
cursor	____	____
menus	____	____
trackball	____	____
joystick	____	____
mouse	____	____
touchscreen	____	____
full keyboard	____	____
dedicated buttons	____	____

(40) There are several ways that RCDS may indicate error bounds on position fixes. Circle Yes(Y) or No(N) to indicate if the following options for indicating error bounds would be beneficial or not.

in numeral terms, with the fix? Y N

in numerical terms, in a window? Y N

graphically? Y N

(41) There are several ways that RCDS may show scale and zoom level. Circle Yes(Y) or No(N) for each of the following possible techniques you feel would be beneficial or not.

variable-length scale bar with real-world distances: Y N
constant-length scale bar showing real-world equivalent of 1 inch: Y N

numerical scale ratio: Y N

(42) Do you consider it beneficial that RCDS will have a **STANDARD COLOR SCHEME** that is the same as the paper chart color scheme? Circle Yes(Y) or No(N) __ Y N

(43) **COLORS AND COLOR CONTRAST** can impact the readability of symbols and text on a RCDS. Circle Yes(Y) or No(N) to indicate if

absolute colors are more beneficial
than high contrast. Y N

or

high contrast is more beneficial
than absolute colors. Y N

(44) What warnings should RCDS provide and what automatic actions should RCDS take if it detects apparent losses or corruption in the raster chart data? _____

_____

(45) Is it beneficial to have the capability to suppress past track and time marks under special circumstances? (for example when at anchor)

on screen? Circle Yes(Y) or No(N) Y N

in recorded log? Circle Yes(Y) or No(N) Y N

(46) When RCDS restarts after a temporary shut-down, should the display settings of the interrupted operation be retained, or should they reset to a default? Circle Yes(Y) or No(N).

Retain settings Y N

Reset to default Y N

(47) Should a printer be a required part of RCDS, to produce periodic "hard copy" records of log entries and voyage events? Circle Yes(Y) or No(N) Y N

(48) If RCDS was made available to you on your ship, would you use it as one of the primary means for making navigational decisions? Circle Yes(Y) or No(N)
Y N

(49) If you have any concerns about using RCDS, please explain. _____

_____

_____

_____

_____

_____

APPENDIX B

Questionnaire Distributed to Experts Using RCDS at Sea: RESULTS

User Profile Questions.

	Mean	Median	Maximum	Minimum
Length (ft.)	257.3	180	856	40
Displacement (dwt)	8,415.5	908	70,367	20
Draft (ft.)	14.2	12	40	4
Beam (ft.)	43.9	34	118	15
Age (yrs)	29.1	30	55	2

Table 1. Respondent's Ship's Profile

Vessel Class	Number
Government	53
Commercial	42
Recreational	0
Not Specified	5

Table 2. Class of Vessels

Complement (#)	N =	Mean	Median	Maximum	Minimum
Officers	82	6.1	6	60	1
Crew	82	98.6	29	949	2
Passengers	23	21.5	216.5	2,634	6

Table 3. Respondent's Ship's Complement

Type of Vessel	% of Total
Coast Guard / Navy Vessels	29%
Pilots (no vessel)	16%
Survey Vessels	14%
Research Vessels	12%
Passenger Cruise Ships	11%
Ocean Tugs / Barges	7%
Miscellaneous Vessels	6%
River Tugs / Barges	5%

Table 4. Vessel types on which respondents serve.

Experience (years)	N =	Mean	Median	Maximum	Minimum
Helmsman	67	5.6	5	39	1
Navigator/Chartwork	85	10.3	8	39	1
Officer of the Watch	73	6.8	6	39	1
Captain/Master	39	3.9	6.5	33	1
Pilot	25	3.4	11	33	1

Table 5. Respondent's experience.

Experience (yrs)	N =	Mean	Median	Maximum	Minimum
Radar	96	12.4	9	40	1
ARPA	77	4.6	5	23	1
GPS	96	4.2	4	15	1

Table 6. Experience with various aids to navigation.

Computer Skill Level: 1 (low) - 5 (high)	**N =**
0 (or blank)	2
1	4
2	9
3	37
4	31
5	17
Total	**100**
Mean	**3.4**

Table 7. Computer Skill Level

Situation	**N =**	**Mean**	**Median**	**Maximum**	**Minimum**
Route Planning	53	62.3	20	500	2
Open Water Passage	46	51.5	12.5	200	2
Coastal Transit	60	65.8	20	500	2
Harbor Approach	71	88.9	50	1000	2
Docking maneuver	39	56.9	25	500	1
Heavy Traffic	52	68.8	45	500	1

Table 8. Estimated voyages using electronic chart displays.

Question	YES
Q: Are you comfortable operating electronic chart displays?	89
Q: Have you received...training in the operation of electronic chart displays?	33
Q: Have you experienced a critical situation...that was avoided due to the rapid access to chart information provided by an electronic chart display?	33

Table 9.

Critical situations avoided due to the rapid access of chart information provided by an electronic chart display.

- heavy traffic movements requiring immediate viewing of the situation with plotted targets shown overlaid on the chart display indicated not only own vessel immediate options, but also those of other vessels.
- heavy pleasure boat trapped in zero visibility
- near grounding - conditions were poor - RCDS helped identify that we were closer to shoal than the OOD/pilot realized. It was at night as well.
- Potomac River at night when there were no lighted aids, the electronic chart aided in positioning ship so as not to run aground.
- navigation in heavy fog with near zero visibility. Also approaching busy harbor entrance at night.
- lost buoy in sea return on radar when ship was in turn of channel.
- electronic chart used in conjunction with radar has been a great help while operating in New York harbor in fog.
- RCDS used extensively for fog navigation.
- used for fog navigation.
- its great when the machine confirms what you already know. Conversely, its a good indicator when you should recheck your work.
- Answered no - I do believe, however, that electronic charts greatly aid in avoiding "in extremis" situations in the first place.
- with RCDS equipped with DGPS you have instantaneous feedback. When encountering other vessels it is easy to assess status of good water available.
- servicing aids to navigation in Horseshoe Bend, approaching Cape May Inlet; transitting Upper Delaware Bay.
- while positioning aids to navigation in the fog on Bulkhead Bar (Delaware River), RCDS showed vessel getting set into shoal water. Without visual ranges we couldn't see our drift. While transitting in the fog it is easy to see where we are in the channel.
- several.
- this is a grey area. We use ECS for route planning, therefore in "best route" electronic displays would readily show where the ship can and cannot go. Thus we are using RCDS as an avoidance against potential grounding, But never in a critical situation.
- staying in a narrow channel or harbor approach channels in fog where buoys weren't visible.
- RCDS gives earlier information than traditional navigational equipment.
- Electronic charts give you the confidence to make radical course changes (i.e. out of the channel, etc.) quickly if risk of collision is present.
- SW Pass, Mississippi River in fog.
- work close to hazards--an electronic chart gives us the real time information on where the ship is in relation to the hazard.
- not a near miss per se, but the ability to act quickly to avoid even a near miss.
- No, however, it is used extensively when we pull in and out of home port.

- positioning boat when meeting in narrow channels.
- MD Pilots - our program assists us in quick reference to the deep water track.
- I use chart information when transitting the Bay on a deep draught ship to remain in the deep water trough.
- surveying close to shoreline in less than 18 feet of water.
- low visibility and anchorage in low visibility.
- We have very accurate vector charts that show exact centerline of the channels and with the DGPS we know accurately where we are in the channel when in fog, ice, etc.
- Inbound Ambrose ship channel. Adverse weather and heavy ship traffic with very poor visibility (fog and rain) was able to maintain correct inbound traffic lane in ship channel, coupled with radar. This would not have been possible without both units. Could have encountered grounding.
- at least once or twice every trip the electronic chart has been extremely useful; heavy rainstorms, snowstorms, fog or a combination of all.
- On several occasions the GPS has assisted in navigation in heavy fog.
- Buoys missing over underwater structures and when approaching area, I was able to stay clear due to the electronic chart.

Situational Awareness	N =	Negative Impact	No Impact	Positive Impact
Open Ocean Passage	95	2.1%	45.3%	**52.6%**
Coastal Transit	95	1.1%	6.3%	**92.6%**
Harbor Approach	97	4.2%	5.3%	**90.7%**
Docking Maneuvers	94	7.4%	**56.4%**	36.2%
Heavy Traffic	96	7.3%	18.8%	**74.0%**
In An Anchorage	96	1.1%	16.7%	**82.3%**

Table 10.

Navigational Safety	N =	Negative Impact	No Impact	Positive Impact
Open Ocean Passage	94	1.1%	48.9%	**50.0%**
Coastal Transit	94	1.1%	7.4%	**91.5%**
Harbor Approach	96	5.2%	1.0%	**93.8%**
Docking Maneuvers	95	11.6%	**49.5%**	39.0%
Heavy Traffic	95	6.3%	21.1%	**72.6%**

Table 11.

Personnel Stress	N =	Negative Impact	No Impact	Positive Impact
Open Ocean Passage	93	0.0%	**53.8%**	46.2%
Coastal Transit	94	0.0%	16.0%	**84.0%**
Harbor Approach	97	3.1%	11.3%	**85.6%**
Docking Maneuvers	94	6.4%	**57.4%**	36.2%
Heavy Traffic	96	6.3%	20.8%	**72.9%**
In An Anchorage	94	1.1%	25.5%	**73.4%**

Table 12.

Questions:

(1) How much time do you normally spend using an electronic chart display to perform route planning activities for a typical voyage? _____ hours

Median: 2.0 hours **Mean: 2.4 hours** **(Respondents: 46)**

(2)

	N =	Less Than 3 Feet	Between 3 and 10 Feet	More Than 10 Feet
Route Planning	67	**82.1%**	14.9%	3.0%
Ocean Passage	73	27.4%	**65.8%**	6.8%
Coastal Transit	85	41.2%	**56.5%**	2.4%
Harbor Approach	91	**52.7%**	42.9%	4.4%
Docking Maneuvers	66	**50.0%**	39.4%	10.6%
Heavy Traffic	84	**52.4%**	45.2%	2.4%

Viewing Distance From the Monitor Under Various Conditions.

(3)

Minimum Allowable RCDS Monitor Size:	Yes
a) About the size of this paper	29%
b) About twice the size of this paper	69%
c) About half the size of this paper	6%

Minimum monitor size.

(4)

Q: Do you see any benefit in being able to control the size of the following RCDS symbols?	
	Yes
Own Ship	82%
Intended Track	74%
Past Track	57%
Waypoint	75%
Time Marks	62%
Course & Speed Made Good	85%
Fixes	75%

(5)

Q: Is it beneficial...in RCDS to display your own ship at the scale of the display under the following scenarios?	
	Yes
Route Planning	40%
Open Ocean Passage	29%
Coastal Transit	58%
Harbor Approach	86%
Docking Maneuvers	83%
Heavy Traffic	72%

(6)

Q: Is it beneficial that the RCDS...look as much as possible like a paper chart under the following conditions?	
	Yes
Route Planning	86%
Open Ocean Passage	75%
Coastal Transit	91%
Harbor Approach	96%
Docking Maneuvers	85%
Heavy Traffic	93%
In Anchorage	93%

(7)

Q: Is it beneficial for RCDS users to be able to change color of the following symbols?	
	Yes
Own Ship	74%
Intended Track	83%
Waypoints	79%
Past Track	78%
Time Marks	66%
Course & Speed Made Good	80%
Fixes	75%

(8)

Q: Have you had any problems with the RCDS display legibility due to any of the following?	
	Yes
Ambient Lighting	51%
Vibration	6%
Screen Size	35%
Other Problems (see below)	30%

Other RCDS display legibility problems:

- Dirty screen, backlight display changes.
- Distance away from screen.
- Keyboard not lighted, requires flashlight for night operations.
- Screen size needs to be large.
- Micromariner has a night vision feature which turns the screen different shades of red making it difficult to see.
- At night the screen is too bright.
- When zoomed in too far resolution degrades; annoying but tolerable.
- Contrast of screen, brightness.
- At increasing detail scanned image deteriorates.
- Symbology inconsistent with IHO standards.
- When shifting from chart to chart or going to an inset and having the ship remain in the center of the screen and the chart move, instead of the ship running into the edge of the screen. When a chart is skewed, the heads up of the vessel is off.
- Input error monitoring.
- Sometimes the raster image is too unrefined (i.e. small print and symbols) for the scale shown on the computer screen. In these cases soundings and other information cannot be read from the screen.
- Poor zooms.
- Zoom legibility is poor at scales larger than 100% size.
- The display must be a high resolution monitor. Medium and low resolution monitors become blurred when dealing with high detail charts when zoomed out.
- The inability to minimize the white background lighting at night.
- The chart itself could be more clear.
- Night-time on bridge - need to reduce screen brightness.
- Space constraints do not allow for additional larger screen display systems; the development of a thinner and larger screen LCD color display would be fantastic.
- Night screen, sunlight, brightness of screen.
- When using chart for normal area of coverage, chart symbols are too small.
- Some displays are too bright and affect night vision.
- The Ohio River chart is almost unreadable because of words being too small.
- [Lack of] keyboard lighting.

(9) Would it be beneficial if RCDS included the capability for **MARINER ENTERED DATA**, such as defining groups of lines, boundaries, or areas of particular interest for a planned voyage?

Yes: 96

(10) Would it be beneficial to have the capability to review present and previous updates to **MARINER ENTERED DATA** displayed on RCDS?

Yes: 89

(11) Data identified as beneficial mariner-entered data in question above:

- Date, person making entry, source and reason for data.
- Date, time, person making entry, NTM number for chart corrections.
- Survey boundaries.
- Date and time and basis of information.
- Basis of information.
- Basis of information and person making entry.
- Basis of information.
- Hangups, areas of soft bottom, projected set and drift for another vessel during emergency situation.
- Date/time, basis of information, person making entry, type of equipment used.
- Date/time, remarks.
- Date/time, basis of information, depth, boundaries of danger areas.
- Any normally accepted chart symbols currently in use.
- Date, time, description of item.
- Who and why data was entered.
- Date/time, source, person making entry.
- Author, date/time of revision,, remarks.
- Type of information, date entered, person making entry.
- Ability to add buoys and channel characteristics (note pilot response).
- Hazards to navigation, position of dredges.
- Date/time entered, who made entry.
- Date/time, basis of information, person making entry.
- Course over ground, speed over ground.
- Previous tracklines, waypoints.
- USCG Group boundaries.
- Date/time, basis of information, amplifying information.
- USCG Group boundaries.
- Date/time, person making entry.
- Date/time, basis of information.
- Date/time.
- Date/time, information entered, notation on source, who entered it and how applied.
- Date/time entered, who entered, numerical coordinates of corners of boundaries/ends of lines, space for comments.
- Date/time, basis of fix, person entering data.
- Date/time, night and standing orders for watch, person entering data.
- Basis of information, source, date/time, person making entry.
- Identifier (such as sheet name, anchorage area radius)
- Have a remarks field associated with mariner entered data.
- Date/time, person making entry, comments.
- Date/time, source, etc. A general operator log would be useful in documenting any changes or observations made.
- Who, when.
- Date/time, basis of information, person making entry, source of data (i.e. NTM, etc.), project which input data relates to.
- The capability to enter date/time, basis of information and person making entry would be nice but would be cumbersome to enter on a dark bridge.
- Date/time, basis of information, person making entry.

- Date, manual code (e.g. "O" for obstruction).
- Date/time, basis of information or purpose of data if not clearly evident, person making entry.
- Who entered it, when it was entered.
- Date/time, basis of information - download, in a generic format, of official updates from a website would be great. A note field could be used for all but the date which should be separate for sorting and selecting changes for review.
- Date/time.
- Date/time.
- Person making entry and where the information came from.
- Date/time and basis of information.
- Date/time, basis of information, who entered it, source of information.
- Date/time, basis of information, person making entry.
- Possibly the ability to write in notes concerning Local Notice to Mariners in the vicinity of transit area; local knowledge type information; danger bearings, ranges, firing exercise areas.
- Due to liability, person who entered data and acknowledgment requirement that each watch previewed the data (previously entered) pertinent to his/her watch.
- User to build a navigation plan (waypoints and ETD/ETA) while RCDS provides for the rest. No manipulation is a safety feature.
- Date/time, basis of information, person making entry.
- Date/time, person making entry, description of information.
- Date/time, basis of information.
- When changes are made to the chart such as buoy repositioning or deletion (removal), non-permanent information such as the positions of spud dredges and the like.
- Date/time, person making entry.
- Date/time, general information for a voyage, identification of person making entry.
- Item being entered, date and time.
- Latitude and longitude, course, speed, current (set and drift), certain weather anomalies.
- Date, time, Notice to Mariners, initials, date (to comply with Navy regulations.
- ETA, ETD, easy change or update.
- Date, time, basis of information, person who entered data, plus exact reference numbers and lat/long.
- If vessels are meeting in channels all vessels using the channel should have the same waypoints showing the same correct centerline of the channel.
- Date and time, basis of information, person who entered data.
- Date, initials.
- When, what, where.
- Date, time, basis of information, person making entry.
- To be able to find out who entered the data and what all the conditions were.
- Basis of information.
- Good marks and reference about areas not transited often.
- Also a timeframe for the need of the information.
- Date, time, basis of information, person making entry, location of data entered.
- Time, person who entered data.
- Reliability, basis of information, date.
- Date, time, data source.
- Date, person who entered data.

(12) Beneficial voyage-specific mariner-entered data:

- Areas to be avoided, areas of insufficient water depth
- Ocean current information (i.e. location of Gulf Stream, other known currents)
- Locations of known shoaling areas (for use in route planning and cruise monitoring)

- Locations of pilot station area.
- Average speed as it effects chart screen updates
- Cross track error and recommend corrective course
- Chart corrections.
- For a cruise ship, the courses where the ship works.
- Only the ability to catalog data under voyage or area parameters would seem imperative.
- Chart corrections, track lines for hydrographic surveying, annotations, danger areas.
- Type of scientific buoys which could be represented by several symbols not to be confused with navigational symbols.
- Depth, temperature, bottom conditions, tide or current info., warning indicator with alarm for upcoming potential hazards to navigation.
- New structures, different depths.
- Work area data, boundaries.
- National Marine Sanctuary boundary.
- Rate of turn at speed, distance of advance for a turn.
- Ship's draft and maneuvering characteristics.
- DGPS beacon locations, major aids to navigation, light houses, etc.
- A transit corridor would be helpful as a general or specific guideline for accepted areas to navigate in (especially useful when less trained people are navigating). Also, either the automatic or manual ability to edit charts based upon Local Notice to Mariners. These should be able to be organized into "layers" or tables.
- Names of routes, waypoints. Length of route segments as well as length of entire route. (to be used for quick estimates and ETA determination).
- Size of ship icon (i.e. accurate or representative); previous voyages entered for route planning purposes; draft/speed of previous voyages and current voyage.
- User defined lines and points (markers) to be overlayed on nautical chart - for use in scientific sampling.
- Waypoints (route planning); tide and current information; celestial rise and set; icon bank for events; ability to correct charts on screen; zoom in/out.
- USCG Group boundaries.
- USCG Group boundaries, area of ship's responsibilities, search areas, patrol boundaries (note USCG response).
- USCG Group boundaries; ships area of responsibility.
- Anything and everything on the IMO pilot card.
- Track lines for survey, SAR grids, depth boundaries, stratum boundaries.
- Port entry hints; notes on landmarks and how to use them; relevant information on currents and weather; notes on pilot, tug and berth; wheel-over points; speed control limits.
- We would greatly benefit from having mariner entered data on specific buoys, such as Light List Number, hull type, service dates, etc.
- Areas of interest, aids to staying inside of or outside of safety zones, marine sanctuary boundaries.
- Add/delete aid to navigation functions (i.e. capability to make chart corrections).
- Time and distance alterations due to speed changes.
- Survey area; chart corrections (NTM).
- Circles of a specific radius (for anchorage); segments; uncharted buoys, obstructions located by the mariner.
- Advance/transfer for marking turn points.
- The ability to enter text, for example, information regarding the harbormaster or defining anchorage information or local boundaries for security zones, no wake areas, etc.
- Define areas of shoal water and special interest.
- Transect lines, dive sites, danger areas, bottom obstructions, text to serve as operational reminders (e.g. VTS checkpoints, etc.).
- Different source information (e.g. LORAN/GPS/Celestial fixes in a multiple display.
- Allow the user to create lines (e.g. boundaries of project, sampling area, etc); setting waypoints, tracklines, marking fixes (i.e. man overboard button.
- Fixed gear, observations of oil spills, closed areas.
- We need to be able to enter stratum boundaries; we need to enter "closed area" boundaries to fishing so that we know what direction to tow in order to stay in desired area; would like to be able to mark with various symbols such things as fixed gear, obstructions not charted, large fish seen on fatho., poor bottom contour, previous towing tracks, etc.
- Past scientific tows, mark obstructions, rocks, specific routes.
- Restricted fishing areas, safety zones, areas off limits, when to notify personnel for project activities.

- Temporary data for moved buoys and ranges.
- Buoy moves, channel and bridge changes. In oil spill response we must move equipment in the channel and into shallow water; depth is very important.
- The voyage or ship specific information desired will depend heavily upon the type of ship using it (i.e. a crude oil tanker will want different information than a fishing vessel).
- Wreck, buoy, boundary.
- Track lines, distances around hazards, color in shoal water.
- Aids to navigation data including position of deployment, chain length, last service date, etc..
- Waypoints, waypoint groups, operational area boundaries, regulatory boundaries, etc.
- Calculated set and drift if "ordered" speed is entered by mariner. Display COG, SOG.
- User to enter navigation plans, ETD, ETA, ship's clock time. System to build up its own statistics to provide a comparative safety feature. Collecting data is basic to improve operation and performance system to provide performance printouts over certain span of time. System to be fed with engine settings, ballast, etc. etc.
- Wrecks, aids to navigation that are out of position, shoaling.
- Visual bearing circles, turn bearing lines, USCG District boundary lines, USCG Group boundary lines.
- Waypoints, pilot information and vessel crew (supplied information would vary).
- Being able to update a chart with new important information, etc.; note incorrect position of buoys.
- If you could add the changes identified in question 11 to the database it would be greatly beneficial then you would not have to reenter every time.
- A useful feature would be the ability to insert tide and current information at specific waypoints along a route.
- Highlight in some obvious fashion shoal areas less than the ship's draft.
- Weather data which could be recalled for future use entering the data in METAR/Synoptic type format.
- Waypoints, points of interest (i.e. anchorages, dropped buoys, mine shapes, etc.).
- Man overboard, buoy, anchor.
- Lines, hatching, grids (SAR), conspicuous objects, names and notations, navigation lines.
- Easily entered and manipulated waypoints and routes. This seems to be a problem with Laserplot. Chart corrections would be good also.
- Route of in and outbound traffic for deepload vessels in Bay and channels.
- The ability to enter vessel draft with an alarm feature.
- Handling characteristics of vessel, rate of turn when docking/maneuvering.
- The ability to change navigational aids names and positions
- The ability to add channel markers
- The ability to mark shoals, bars, reefs.
- Being able to add buoys where channel has changed and has been re-buoyed.
- River condition, wind speed, visibility.
- Marking sunken objects or objects not marked by buoys or on chart, shoals, shallow water.
- Easy scroll through voyage so I could check different markers before I reached that area.
- No-go areas; caution points; reporting points; communication points.

(13)

Q: What method of notification...would benefit you when dealing with...OFFICIAL GOVERNMENT AUTHORIZED updates, corrections, cautionary notes, or Notice to Mariners on RCDS?

	Yes
Pull Down From WWW	62
Inmarsat	40
Diskette/Courier	59
Diskette/PS	69

Preferred methods of delivering RCDS updates.

(14)

Q. Is this feature beneficial to you during Route Planning.?	
	Yes
User Defined Areas	86
Way Points	89
Lines Not to Cross	82
Range and Bearing	73
Planned Routes	86
Alternate Route	68
Depth/Height Units	86
Larger Scale Chart	90
Smaller Scale Chart	87
Cautionary Notes	79
Scale and Distance	89
Chart Scale Boundary	78
RNC Edition Date	83
Geodetic Datum	59
Magnetic Variation	66
Latest Update	88

(15)

Q. Is this feature beneficial to you during Cruise Monitoring?	
	Yes
User Defined Areas	94
Way Points	90
Lines Not to Cross	88
Range and Bearing	87
Planned Routes	87
Alternate Route	68
Depth/Height Units	89
Larger Scale Chart	92
Smaller Scale Chart	89
Cautionary Notes	81
Scale and Distance	89
Chart Scale Boundary	75
RNC Edition Date	70
Geodetic Datum	54
Magnetic Variation	73
Latest Update	77

(16)

Q. Suppose you could select features that would either always be presented on the screen or could readily be called up. Would you choose to have this feature available for DISPLAY?

	Yes
User Defined Areas	91
Way Points	84
Lines Not to Cross	87
Range and Bearing	86
Planned Routes	90
Alternate Route	65
Depth/Height Units	89
Larger Scale Chart	88
Smaller Scale Chart	86
Cautionary Notes	77
Scale and Distance	89
Chart Scale Boundary	73
RNC Edition Date	71
Geodetic Datum	61
Magnetic Variation	68
Latest Update	79

(17)

Q: In one look at the RCDS display, how far ahead do you need to look ahead in the following situations?

	Distance (nm)			**Time (hrs)**		
	N =	**Mean**	**Median**	**N =**	**Mean**	**Median**
Route Planning	49	111.7	30	34	15.9	5.5
Open Ocean	54	73.4	45	41	8.8	4
Coastal Transit	65	30.7	15	49	4.0	2
Harbor Approach	70	9.2	6	53	1.5	0.5
Docking	56	1.7	1	44	0.9	0.2
Heavy Traffic	67	6.1	5	48	0.7	0.5

(18)

Q: RCDS may provide Optional Radar information in the form of full radar video, ARPA targets, or both. Circle Yes or No to indicate if you feel FULL RADAR VIDEO, ARPA TARGETS...would be beneficial or not on the RCDS display for each of the following purposes:

	Radar	**ARPA**
For assessing the overall navigation situation	83	85
As an aid in interpreting radar	81	74
For evaluating options open to target vessels	69	81
For grounding /collision avoidance	85	81

(19) Under what circumstances, such as heavy traffic, nighttime, navigating without Differential GPS, or visibility limited by weather conditions, would you choose to activate the **OPTIONAL RADAR**?

- Limited visibility, heavy traffic, costal approach.
- To check aids to navigation location and existence and as aid to identify targets.
- Nighttime, bad weather conditions.
- Probably in heavy traffic, but don't mind using independent radar. Full radar video is less useful that ARPA target display.
- ARPA targets under all conditions; full radar is potentially confusing (an on/off toggle for radar display would be useful.
- Heavy traffic, limited visibility.
- Fog and heavy traffic.
- Heavy traffic, night sailing, no DGPS, limited visibility.
- Heavy traffic, nighttime, no DGPS, limited visibility, unfamiliar areas.
- Limited visibility.
- Heavy traffic, nighttime, lack of DGPS, limited visibility.
- Heavy traffic, nighttime, fog or reduced visibility, vessel traffic.
- Nighttime open ocean transits; coastal and harbor transits to evaluate options open to each vessel.
- Always except in open ocean.
- Visibility limited by weather conditions.
- Heavy traffic; low or no visibility; should be very easy to toggle between radar mode and non-radar mode.
- Heavy traffic, low visibility, no DGPS.
- All conditions - integration of radar desirable.
- Heavy traffic, fog, coastal.
- Nighttime, restricted visibility.
- Fog, rain, heavy traffic, navigating with no DGPS.
- Operating without DGPSD, low visibility.
- Heavy traffic, low visibility, unfamiliar waters, nighttime, operating without DGPS.
- All the time when available.
- Heavy traffic, low visibility, unfamiliar waters, nighttime, operating without DGPS.
- Heavy traffic, low visibility.
- Heavy traffic, limited visibility, approach to port.
- Heavy traffic.
- At all times. Information provided by radar may be most useful when you don't expect to need it.
- Heavy traffic or when meeting vessels at night.
- Low visibility (fog, rain, etc.).

- Limited visibility, nighttime.
- Heavy traffic, nighttime, no DGPS, limited visibility.
- Heavy traffic, low visibility.
- I'm not yet convinced that I would use an optional radar display on the electronic chart. I'm not sure how cluttered it would look.
- Heavy traffic, low visibility, training.
- Under any circumstances that make another vessel's identity, actions or intentions difficult to judge.
- Nighttime, visibility limited by weather conditions.
- Heavy traffic, navigating without DGPS, poor visibility. Optional radar would aid the mariner by depicting special orientations of targets and fixed aids to navigation.
- Only in poor visibility to help verify that a contact is a nav aid, but even that is easy enough to do on a paper chart.
- Limited visibility with heavy traffic in coastal areas or approaches; nice feature but not absolutely needed.
- Heavy traffic, limited visibility; I find it best to be able to turn it on and off as needed.
- Heavy traffic, restricted visibility, nighttime.
- Spill response commonly involves up to 10 vessels 20 ft to 120 ft, plus a ship. It could be a valuable training tool and progress monitoring tool.
- I would activate the optional radar during all periods of restricted visibility and coastal transits.
- River, harbor.
- I would turn on optional radar during coatal transits and leave it on.
- All time.
- Low visibility, risk of collision, harbor approach, heavy traffic.
- Low visibility, highttime navigation.
- Ice, restricted visibility scenarios.
- Heavy traffic, poor visibility.
- Adverse weather conditions.
- Heavy traffic, DGPS failure, low visibility, channel transit, buoy operations.
- Heavy traffic, limited visibility.
- All conditions.
- Under all conditions.
- I prefer to use the RCDS and radar units separately - as a check on each other. The combined radar/RCDS mode is not of interest to me. I prefer two separate, stand alone sources of navigation information.
- Optional radar would be activated and used during the entire journey.
- All the time!.
- Any time needed.
- During approaches to unfamiliar ports or during long transits in rivers, large harbors or canals.
- Limited visibility.
- The radar overlay would always be helpful because it shows targets that are not on the chart.
- (1) heavy traffic (2) transit ship channel (3) adverse weather and restricted visibility (4) safety fairways (4) open ocean and coastline transit when in traffic or fairways.
- Heavy traffic, nighttime, no DGPS, limited visibility and adverse weather.
- Heavy rain or snow.
- Limited visibility.
- Weather conditions. Heavy rain or snow. High wind swells.
- Visibility limited by weather conditions.
- When buoys and channel markers are missing.
- Always: used as black box function.
- Approaches with traffic, fog, etc.
- In heavy traffic situations and bad weather conditions and reduced visibility.
- In all cases when we need to confirm data.

(20) Would your preferred color scheme for optional radar presentation on RCDS be different for day and night?

Yes: 73

(21)

Q: Is it more beneficial to have the radar image be: (a) on top of both the route information and the chart, (b) under the route information, but on top of the chart, or (c) under both the route information and the chart?	
	Yes
a) Top	46
b) Between	29
c) Bottom	27

Position of radar image.

(22)

Q: RCDS may allow different display MODES of MOTION. One possible mode would be TRUE MOTION... another possible mode would be RELATIVE MOTION. Please circle Yes or No to indicate if you would use TRUE MOTION or RELATIVE MOTION or EITHER (circle both Y's), for each of the following:		
	True Motion	Relative Motion
Open Ocean	56	68
Coastal	68	70
Harbor	70	62
Docking	64	52
Traffic	68	63

True motion vs. relative motion.

(23) In RCDS, using true motion mode, you may be able to control the distance from the ship's symbol to display boundary at which the RCDS redraws the chart display. Would this capability be beneficial to you?

Yes: 86

(24) In RCDS, using true motion mode or relative motion mode, you may be able to "suspend" the automatic redrawing action? Would this capability be beneficial to you?

Yes: 62

(25)

Q: In RCDS, using relative motion mode, you may be able to place the ship's symbol in the middle of the screen when the screen is redrawn, or ...off toward the side to give you more view of the route ahead?

	Yes
Middle	67
Off-center	82

Position of ship's symbol.

(26)

Q: RCDS may allow north-up or course-up **CHART ORIENTATIONS** for cruise monitoring. Indicate your probable use of **COURSE-UP** or **NORTH-UP** chart orientation under each of the following circumstances.

	Course-Up	North-Up
Open Ocean	11	78
Coastal	11	77
Harbor	20	75
Docking	31	64
Traffic	22	72

Orientation of chart while in transit.

(27) If the electronic positioning sensors fail, would it be beneficial for RCDS to calculate and display the position error bounds on positions based on dead reckoning (for example, speedlog and gyro input)?

Yes: 77

(28) Would it be beneficial for you to be able to manually enter the ship's position information?

Yes: 68

(29)

Q: RCDS may provide a WARNING when the RCDS detects a dangerous situation. Please circle Yes(Y) or No(N) to indicate if you prefer AUDIBLE WARNING, VISUAL WARNING, BOTH (circle both Y's), or NEITHER (circle both N's), for each of the following.

	Audible Warning	Visible Warning
	Yes	Yes
Off-track Error	71	79
Mariner Line	76	73
Avoidance Area	72	81
Overscale	26	55
Larger Scale RNC	25	72
Different Reference System	36	68
Deviation From Route	63	72
Failure of Position	89	88
Loss of DGPS corr.	79	90
Critical Waypoint	79	80
Fails Self-Test	89	85
Malfunction of RCDS	90	88

(30) Would it be beneficial for the RCDS user to be able to suppress visual and audible warnings in RCDS?

Yes: 87

(31) Would it be beneficial to navigational safety if the RCDS visual and audible warnings were standardized for all RCDS manufacturers?

Yes: 75

(32)

Q: What data should be included in the electronic log record that RCDS keeps of the ship's voyage?

	Yes
Time	95
Ship Position	95
Course and Speed	96
ARPA Targets	59

Data that should be included in the electronic log.

(33)

Q: How much data should RCDS be required to keep, and how frequently should it be recorded under the following scenarios?									
Scenario	Days			Minutes			Recording Interval		
	N =	Median	Mean	N =	Median	Mean	N =	Median	Mean
Open Ocean	44	7.5	24.1	5	15	36.2	48	30	48.1
Coastal Transit	45	7.0	30.1	5	20	41.6	51	15	31.2
Harbor Approach	40	9.5	33.0	12	45	56.8	51	5	13.0
Docking Maneuvers	35	15	38.6	10	12.5	25.7	40	1	3.2
Heavy Traffic	37	14	35.0	12	22.5	41.2	46	3	5.5

(34) Do you feel that playback of RCDS voyage records, is likely to be beneficial in training ship operators?

Yes: 83

(35)

Q: Would you prefer to have a separate window or separate screen for look-ahead and route editing, so that you can continue to track the ship's current position while simultaneously looking ahead. Or would you prefer to switch between look-ahead and present location by a single action?	
	Yes
Separate Window	53
Separate Screen	25
Switching	53

(36) Is automatic boundary and area detection/warning a necessity if the RCDS allows the user to have the ship off the screen for look-ahead or route editing?

Yes: 57

(37) What additional beneficial navigation tools and capabilities would you like to see built in to RCDS?

- Ability to layer available chart data on screen (i.e. turn off soundings in deep water)
- Approved and effective chart correcting system
- Depth finder
- Easy updates from NTM via floppy disk or manual editing
- Coast Pilot on line; tides/currents on screen; sunrise/sunset; user annotations
- Keyboard screen to enable operator to enter text without typing on a conventional keyboard
- Small screen showing height of tide for closest geographic tide gauge. Also have the ability to input data (and display) from other sensors (i.e. anemometer, fathometer, barometer)
- Ability to change aids to navigation; distance off centering in channels (pilot response)

- Switch to next chart ASAP when switching charts rather than waiting until the end of present chart.
- Ability to automatically shift to best scale chart when available (two respondents)
- An adjoining chart table for RCDS (i.e. workstation) rather than typical space available add on
- Standardized keyboard and commands
- Chart update/correction capabilities
- Anchor radius (boundaries); activation of an alarm when vessel goes outside of a designated area such as an anchorage circle
- Automatic chart sequencing - where the next chart for your route automatically appears. Ability to zoom in and out and scroll
- Like radar, a cursor centered on the ship which can be moved about the screen by mouse/trackball giving range/bearing and position of the cursor
- Capability to see a continued display of a waypoint range/bearing after it has been passes. Quick zoom capability.
- A CD jukebox for charts
- Need a very flexible cursor function, specifically range and bearing from any position, not just from own ship
- Should have CAD functions, e.g. zoom window (no fixed zooms), up/down and left/right sliders, circle tool, rubber band line tool (flexible cursor), annotated marks, freehand line
- Would be very nice to merge adjacent charts especially where there is minimal overlap.
- Pull down menu showing present chart and all alternative charts with scales
- Graphical chart catalog, click on chart you want to load. Activated by hot key or pull down menu.
- Simple hot keys: cursor on/off, zoom in/out, mark, erase or undo marks, "find me" feature, start/end special line
- Why only 254 pixels/inch when laser printers can show 600 dots per inch. High resolution is better for extreme zooms. Video displays should be 1275 x 1024 or at least 17 inch monitor (21" better)
- For scientific uses, bathy maps and sheets with higher density soundings are very useful (special CD?)
- Add a milage range so you can go to a preferred distance
- Anchoring page, man overboard page, engine room monitoring
- Design the software for the ease of the user
- Interfaced with auto pilot and speed control, valid alternative positioning method, interface to tank sounding and loadmaster, interfacing with computer workstation software to elaborate navigational data, printer to check out plans, and tutorial program
- System to be customized by supplier to suit vessel's features. No manipulation is a safety feature. User to cross-check alternative systems - keep system lean and basic in order to enhance dangers
- Voyage data to be downloaded and saved after completion of voyage
- Data for docking and harbor approaches should be kept longer periods of time due to increased time of liability for these situations
- All capabilities of the RCDS should be controllable by its user. (Auto boundary and area detection warnings may or may not be turned on by its user, etc.) If I have a portable RCDS it should be able to be hooked into the ship's DGPS system via a port that the ship's system has built in for peripherals.
- The capability to plot a position using visual bearings and radar ranges.
- (1) moving waypoints (2) automatic calculation of position of intended movement along a track (3) user configurable symbols (4) ability to add many tracks on one chart without having to interconnect all of the waypoints.
- Integrated with NAVTEX for instant NTMs; larger screen enabling user to look farther ahead on chart without losing legibility
- Ability to override GPS information when it is in error
- Do away with waypoints for Inland and Western River use; put notes that are visible at all times on each chart page
- Turning off alarms; temporarily switching to next chart
- I would like to see the movement of other vessels on the display and be able to calculate their speed.
- Speed average that you can call up for any amount of time you want

- Echogram, tides and currents; radio aids, pilot's almanac.

(38) There are several possible methods that RCDS could use to present alphanumeric information such as **CHART NOTES**. Circle Yes(Y) or No(N) to indicate if you feel one of these options would be beneficial or not.

	Yes
(a) pop-up windows	78
(b) dedicated area	22
(c) separate screen	25

(39)

Q: There are several possible methods that RCDS could use to present alphanumeric information such as **CHART NOTES**. Circle Yes(Y) or No(N) to indicate if you feel one of these options would be beneficial or not.

	Acceptable	Not Acceptable
Curser	70	27
Menus	82	13
Trackball	76	18
Joystick	49	43
Mouse	72	22
Touchscreen	61	35
Full Keyboard	58	35
Dedicated Buttons	73	22

Methods for accessing text information.

(40) There are several ways that RCDS may indicate error bounds on position fixes. Circle Yes (Y) or No (N) to indicate if the following options for indicating error bounds would be beneficial or not.

	Yes
(a) numerical terms/fix	46
(b) numerical terms/window	51
(c) graphically?	66

(41) There are several ways that RCDS may show scale and zoom level. Circle Yes(Y) or No(N) for each of the following possible techniques you feel would be beneficial or not.

	Yes
(a) variable-length scale bar with real-world distances:	78
(b) constant-length scale bar showing real-world equivalent of one inch:	44
(c) numerical scale ratio:	60

(42) Do you consider it beneficial that RCDS will have a STANDARD COLOR SCHEME that is the same as the paper chart color scheme?

Yes: 85

(43) COLORS AND COLOR CONTRAST can impact the readability of symbols and text on a RCDS. Circle Yes (Y) or No (N) to indicate if:

	Yes
(a) absolute colors are more beneficial than high contrast.	33
or	
(b) high contrast is more beneficial than absolute colors.	52

(44) What warnings should RCDS provide and what automatic actions should RCDS take if it detects apparent losses or corruption in the raster chart data?

- Audible and visual alarm (23 Respondents)
- Visual warning indicating data lost or corrupted. Loss of position signal results in change to DR tracking and shows different color or flashing and switch to log speed input carried out automatically
- Visual warning
- Recommend reinstallation of chart in a pop-up window
- Do not display incorrect (corrupted) data
- Audible warning to operator
- Visual screen warning
- Pop up window
- Visual warning
- Audible alarm
- An audible and visual alarm that must be acknowledged/ then self-test to correct problem
- Distinct/loud noises and screen flashing on/off
- Audible and visual alarms; pop-up window indicating nature of problem
- Remove raster chart and just show vessel on lat-long grid with an error message
- Visual warning. RCDS should move to a next scale chart (smaller)
- Audible alarm, switch to alternate chart if available
- Visual error code
- Display a visual error code
- Sound warning and reinitialize system
- Low level, low intensity, visual signal - no noise
- No automatic action; visual and audible alarms and information
- Visual warning, audible alarm
- Visual and audible warnings every few minutes
- Different screen color/audible alarm
- Pop-up screen and audible sound
- Notice to change CD. Message -"dead reckoning - lost GPS". No automatic action
- Flash messages on screen with an audible sound
- Audible warning
- Visual error window with an "ignore" option
- Audible and visual alarms; describe the nature of the problem if possible
- Visual alarms and system should automatically load chart scale up or down
- Alarm to warn mariner.
- Audible and visual, display message with slow blink, shift of latitude and longitude grid same scale as the one in use, maintain all capabilities on new mode.
- Use the previous chart with a warning scrolling across the top of the screen indicating error in data.
- Visual warning (flashing) and then system should go into an automatic rebooting mode
- Visual on screen warning
- Large error message.
- Choose the next available scale chart, sound an alarm and visually cue the user as to the problem which occurred.
- Notify user with warning on the screen

- Audible and visual warnings to operator and corrective information to perform operations to secure unit
- Visual warning that has to be reset every so often
- Audio and visual warnings of loss, and the same for resuming normal operations
- Audible warning and visual warning - what the problem is and the fix
- The system should have a bell to warn you that the data is not right
- Audible warning
- Audible sound such as beeps and automatic reset of area that system failed
- Audible and visual - check if larger/smaller chart is available and display

(45) Is it beneficial to have the capability to suppress past track and time marks under special circumstances? (for example: when at anchor)

	Yes
(a) on screen?	88
(b) in recorded log?	34

(46) When RCDS restarts after a temporary shut-down, should the display settings of the interrupted operation be retained, or should they reset to a default?

	Yes
(a) Retain settings:	81
(b) Reset to default:	19

(47) Should a printer be a required part of RCDS, to produce periodic "hard copy" records of log entries and voyage events?

Yes: 64

(48) If RCDS was made available to you on your ship, would you use it as one of the primary means for making navigational decisions?

Yes: 71

(49) If you have any concerns about using RCDS, please explain.

- RCDS cannot be used for docking maneuvers. Nor should this be an option. RCDS cannot replace visual perspective in narrow channels for ship handling and it should not be encouraged, particularly during restricted visibility in restricted waters (Note: this responder IS not equipped with DGPS)
- Chart corrections - approved standard IMO - Standardized transponders/RCDS interface - (VTS Systems)
- Charted features change, including depths. RCDS can lure a mariner into a false sense of security. RCDS should be used as a navigation tool in conjunction with traditional navigation tools. RCDS does not replace looking out the window. This operator has witnessed watch standers relying very heavily on RCDS. NOS, USCG and other international participants need to quickly update charts using side scan sonar and GPS located nav aids and landmarks.
- It should always be kept in mind that RCDS is just an aid to navigation
- I want charts to look like charts. I will always work on paper and I want to be able to go from one to the other (electronic to paper and back) easily. Electronic tools should mimic real tools, pencils, erasers, dividers, etc. I want to be able to put notes on an electronic chart, draw lines, arcs, maybe even work with sight reduction and celestial plots on the computer.
- Lack of corrections for raster charts; fragile navigation system; degradation of situational awareness (i.e. driving the chart vs the ocean).
- Need for automatic distribution of chart corrections and timely update of chart errors;
- Use of additional monitors without keyboard (e.g. Captain's cabin, wardroom, bridge).
- Reliability, standardization and proper certification of the unit and its operator (also the installer).
- Would use only as another tool.

- DGPS is more accurate than most of the charted features. Mariners may assume that because they have the ability to zoom in, they will have higher accuracy information.
- Should require RCDS users to pass some minimal test requirements.
- Need frequency of chart updates maintained
- Need standardization of RCDS maintained.
- Need training by approved institutions and certificates required.
- Need ability to customize routes, scales, etc. to local needs .
- Need to maintain ease of use.
- Need ship scalable to actual size in larger scale charts for anchoring and channel work.
- Updating chart with Notice to Mariners should be frequent is a must if RCDS is to replace paper chart.
- Ability to dim it sufficiently to keep pilot house dark yet still see the screen
- It only works if the electrons keep flowing
- RCDS is a help, but in my opinion is secondary - you must follow the navigation always with normal charts because, for any reason, when any temporary damage happens you must have the situation clear and under control. This can be possible only if you use normal charts and radars.
- Lack of portability (for planning purposes).
- Back-up power, susceptibility to power fluctuations
- Zoom to inadequate/inappropriate scale
- Removal of any data (through layering) found on paper charts
- Inability to correct and/or input manual fix/bearing lines or radar ranges on any charted point
- Non-standardized keyboards/commands
- Equipment not ruggedized for shipboard use
- If the trend is toward doing away with paper charts in favor of electronic chart systems, we need to make sure that we support these systems with excellent back-up power systems and the ability to manually plot positions on-screen using other than electronic means to obtain a fix. (A power loss is the only time I could see entering manual fix information, or a loss of DGPS.
- I see RCDS as a tool, not as a replacement for the paper chart. Major concern - the version of ENC software we used switched to dead reckoning when there was even a minor glitch in GPS control and \did not give adequate, continuous warnings that it was no longer tracking with GPS (very dangerous).
- With our version of RCDS (Infonav, ver. 2.0), if DGPS is lost, the system reverts to DR mode. If the warning message is removed from the screen or not seen, the watch officer may not realize that the DGPS signal has been lost. This may cause navigational confusion.
- I have used Chartnav and seen it place the ship 1 nm off course. The RCDS gave no indication that the position was faulty. The only solution was to reboot - no explanation for positioning error was found. Although I have used Chartnav for over 1 year I do not trust it without comparing to radar fixes and the paper chart. Having said all this, nothing beats Chartnav when it comes to planning cruise tracks and station locations and station boundary limits for scientific sampling.
- I do not feel comfortable using RCDS in restricted waters, entering harbors, docking. I also think that overlaying ARPA would make it too busy. I prefer to use the RCDS solely as a means of planning station routes for scientific operations. There have been several accessions where we have noticed Chartnav showing the ship on land while we are going into a harbor or transitting a canal. We don't want to make it convenient for us to start relying on electronics in situations where we should be looking out the window.
- Charts not updates; poor quality of raster reproductions; user friendliness.
- I use it primarily for training, higher resolution printing and display. Print options for titles cut and paste to other applications would be beneficial.
- Making corrections to RCDS charts is poor. If each ship had an account with NOAA/DMA then that ship could go on line once or twice a week and down load corrections to each chart.
- The possibility that a logged recording could be used like an airlines "black box recorder" as evidence against any mariner will detract from its appeal and usefulness as a navigational tool!
- Nautical chart to be kept fully updated to plot ship's position and study RCDS coastal and ocean cross

maps to be lean and essential; RCDS coast maps to show SOPEP (?) limits and bathymetric lines 100 meters as standard. RCDS display codes and colors to be standardized; radar ???; alternative method to position recognized by ENC; statistics of the voyage with highlight on substantial changes; record collision data and avoidance; record of vhf activity; ???; smart navigation system ???; charts to be marked with SOPEP avoidance area and with bathymetric curves.

- The electronic chart should be a duplicate of the NOAA paper chart.
- Means must be available to draw bearing lines and distance arcs on the electronic chart.
- Positions can be plotted from visual bearings and radar ranges.
- Alarms for truly essential features only.
- RCDS is a great 'aid to navigation'. As with all aids to navigation, the mariner is cautioned that they should not make navigating decisions based "solely" on one aid to navigation. The new young computer literate are placing too much faith in electronic charts! Ask the captain of the ROYAL MAJESTY what he thinks about that!
- The RCDS helps with speed and position but to me is not very helpful in the navigation of the boat.
- (1) A good anchor alarm system would be nice allowing you to enter yards from anchorage. (2) Reliance on these systems can be hazardous. Too many mariners are becoming "over-reliant" on GPS/DGPS systems without keeping skills in celestial and other electronic means fresh in mind. It must be remembered, a computer will last until it crashes - then what?
- For the Navy's desire to use visual navigation in harbors and coastal, the ability to designate objects and triangulate ships position would be useful.
- Would prefer that all resources were directed towards vector solutions rather than raster.
- Very uncomfortable in running a chart without being able to position tug in reverse setting. Constant indication of degree of accuracy of position. Having a chart show larger area without loss of legibility.
- I can foresee problems using this information as legal documents, when there is no way to verify if it is correct. The machine always thinks it is right, whether the position shows you is true to life. Also if it can be retained cannot it also be altered to suit some purpose.
- There are many positioning errors. This may be due more to chart error.
- Accuracy of charts in river sections.
- I wish charts were more accurate with GPS. Note: I work on Mississippi River Systems and alot of questions were directed to Open Water Vessels. I have alot of strong currents and narrow channels to navigate through. RCDS needs to be designed differently for rivers.
- Compatibility with GPS/DGPS. A lot of charts are based on much older datums (less accurate position).

APPENDIX C

Questionnaire Distributed to Experts Other Than Mariners Using RCDS at Sea

The results of the RCDS Standards questionnaire administered to a panel of OCS in-house experts January 22, 1997, have been tallied and the handwritten comments recorded. The average scores for each question are shown below the question. The scores have been broken out by marine specialty as follows:

Average Score // Specialty 1 / Specialty 2 / Specialty 3 / Specialty 4 / Specialty 5

Where:
Specialty 1 = Master Mariners (n = 6)
Specialty 2 = Maritime Administrators (n = 2)
Specialty 3 = Cartographers (n = 18)
Specialty 4 = Hydrographers (n = 5)
Specialty 5 = Marine Tech./Other (n = 7)

All comments have been logged and are shown below the score box. The number in parentheses preceding each comment identifies the marine specialty of the respondent. The number in brackets refers to the paragraph number in the RCDS performance standard.

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1. The RCDS should be capable of displaying digital facsimiles of paper charts which are originated by, and distributed on the authority of, government-authorized hydrographic offices. [1.4, 2.1.2]

Total	M. M.	M. Ad.	Carto.	Hydrog.	Other
9.3	9.6	9.0	9.5	9.4	8.7

(3) Familiarity of chart is important vs. ECDIS.

---

2. The RCDS should reduce workload as compared to that when using the authorized paper chart for similar functions such as route planning, route monitoring, and voyage recording. [1.6]

Total	M. M.	M. Ad.	Carto.	Hydrog.	Other
7.7	7.0	7.5	7.1	9.4	8.7

(1) Does not need to be better than the chart, only equal in functionality.
(3) The QM will still make his/her own decisions.
(5) But [I would give a] "10" to "being no worse than paper chart."

---

3. The RCDS should facilitate simple and reliable incorporation of updates to the raster chart data sets, as such updates become available. [1.5]

Total	M. M.	M. Ad.	Carto.	Hydrog.	Other
9.2	9.2	8.5	9.4	9.2	8.9

(1) Need be no better than the paper [chart].
(3) Data sets need to be defined: critical data only? Complete new chart edition? Both?
(3) Should allow user to enter other updates also.
(3) As long as there is a system of checks and balances in place (quality control).
(5) Dependent on updates by Second Mate or chart corrector.

4. The RCDS should be capable of displaying data for safe navigation which is supplemental to the chart facsimile, such as scale of original chart, horizontal datum, vertical datum, and the units of depths and heights.

[3.3]

Total	M. M.	M. Ad.	Carto.	Hydrog.	Other
8.6	9.5	8.0	8.6	8.8	7.9

(3) This is crucial when there are power glitches, outages, etc., for a PC displaying the RCDS. Paper chart backup.

---

5. The RCDS should have at least the same reliability and availability of presentation as the authorized paper chart.

[1.7]

Total	M. M.	M. Ad.	Carto.	Hydrog.	Other
9.6	10.0	9.0	9.9	9.6	8.9

(1) Unclear.
(3) Absolutely.
(5) Not sure how the same reliability could be guaranteed with the problems that may occur with the power supply. Some presentations could be waived. I score this question a '10' for reliability and '7' for presentation.

---

6. The RCDS should have two display modes, as follows: STANDARD Display, display of the raster chart at the scale of the original paper chart. VARIABLE Display, display of the raster chart at a larger or smaller scale than that of the original paper chart.

[3.2]

Total	M. M.	M. Ad.	Carto.	Hydrog.	Other
7.7	9.0	8.5	7.3	8.0	7.1

(no comments)

---

7. The RCDS should present the STANDARD Display at any time with a single operator action.

[3.3]

Total	M. M.	M. Ad.	Carto.	Hydrog.	Other
8.5	6.7	9.0	8.5	9.4	9.4

(1) One display (variable) is all that is needed.
(3) Larger scale displays of chart area should include warning of data accuracy and reliability.
(3) Could be problems of accuracy when display is larger than 1:1.
(5) With the generally small screen size it is important to be able to zoom to a subset of the chart area you are transiting.
(5) Would only provide largest scale info provided.
(5) But any display other than original scale will seriously degrade the image.
(5) Should default to Standard (zero operator action).

8. The RCDS VARIABLE display should be: (a) limited to scale variations between one-half and twice the scale of the original chart, (b) limited to scale variations between one-quarter and four times the scale of the original chart, or (c) only limited to scale variations based on legibility.
[-]

	Total	M. M.	M. Ad.	Carto.	Hydrog.	Other
a.	**5.1**	3.3	6.5	5.2	9.4	2.7
b.	**4.4**	4.2	7.0	4.3	6.2	3.0
c.	**5.8**	8.2	6.5	5.4	3.6	6.0

(1) I think it should be limited in larger scale but not smaller.
(3) As long as [there is a Variable Display mode available].
(3) Rescaling raster pixels?
(5) [This should be] unrestricted. Let mariner decide what is useful to him.
(5) Inferring source?
(5) You're only talking about zoom features.

---

9. The RCDS VARIABLE display should include an indication of actual display scale when information is displayed at a LARGER or SMALLER scale than the original paper chart.
[3.3]

Total	M. M.	M. Ad.	Carto.	Hydrog.	Other
8.3	7.0	9.5	8.4	9.6	8.0

(3) Larger scale displays of chart area should include warning of data accuracy and reliability.
(3) Scale tends to be misunderstood by most users--the display system should prevent use beyond the implied data accuracy.
(5) When at larger than standard scales.

---

10. Upon start up, the RCDS should first present the STANDARD display of the largest scale applicable chart that includes the ship's position.
[3.4]

Total	M. M.	M. Ad.	Carto.	Hydrog.	Other
8.3	6.0	9.5	8.6	9.4	8.3

(1) Full chart might be a better startup picture, followed by easy operator shift to Standard [display].
(3) With options to select from list of other scales.
(5) Should always come up at chart scale.

---

11. The RCDS should indicate if there are other applicable scale charts in the area than the one displayed and which are resident within the RCDS.
[5.1]

Total	M. M.	M. Ad.	Carto.	Hydrog.	Other
8.0	7.5	9.5	8.6	9.0	5.8

(3) Especially if larger scale charts are available.

---

12. The RCDS should indicate when the ship's position is covered by a raster chart data set from a particular government hydrographic office at a larger scale than the one displayed.

Total	M. M.	M. Ad.	Carto.	Hydrog.	Other
8.1	8.2	9.5	8.4	8.8	6/4

(3) Assume that both raster sets are in the RCDS, otherwise, how would it know?
(3) If it is politically possible.

---

13. The RCDS display should be capable of complying with the resolution recommendations of IHO. (864 pixels across the smaller dimension of the chart display's height or width)
[9.3]

Total	M. M.	M. Ad.	Carto.	Hydrog.	Other
7.8	5.5	8.5	8.4	8.2	7.8

(1) Hard to understand this question.
(1) No way to judge without looking at a display.
(3) What about displaying at multiple resolutions (e.g., 254, 762, 1056, etc.). Should conform to a min/max resolution requirement.
(4) What are current RCDs capable of?
(5) [I have] no opinion on [resolution] value. Legibility should be [the] criteria.

---

14. The ship's position and track lines displayed in RCDS should be automatically updated from a continuous positioning system consistent with the requirements of safe navigation.
[10.4.4]

Total	M. M.	M. Ad.	Carto.	Hydrog.	Other
9.1	7.3	9.5	9.3	10.0	9.1

(1) [In] default condition system should also allow user specified interval.
(1) This is a very important function--highly desirable but NOT a function presently available with paper charts. If we are looking for what features make this equivalent to the paper chart, this is not necessary.
(2) Should there be a provision to warn the mariner about position resolution errors on old charts versus modern ship positioning GPS)?

---

15. [No Question]

---

16. The RCDS' contribution to safe navigation may depend on the size of the display. The effective size of the chart representation for route monitoring should be such that the diagonal measurement is NO LESS than:
[9.2]

Size	Total	M. M.	M. Ad.	Carto.	Hydrog.	Other
9"	**2.7**	4.3	6.5	2.9	1.6	0.6
10"	**2.7**	4.2	6.5	2.7	1.6	1.2
11"	**3.9**	5.0	7.0	3.6	3.2	3.6
12"	**4.8**	5.6	7.5	3.9	5.4	5.4
13"	**5.4**	5.8	6.5	4.9	6.0	5.6
14"	**6.6**	6.8	7.0	6.3	7.4	6.7
15"	**6.4**	7.2	7.0	6.5	8.4	3.7
16"	**6.9**	8.8	6.5	7.3	8.0	4.0

(1) This depends entirely on the size and speed of the vessel.
(2) Highly dependent on where the vessel operates... e.g., a vessel transiting the ocean needs a display of zero inches.
(3) This is more a function of vessel size, capability, and space available [on the bridge].
(5) Note: ECDIS requires a 17" monitor!
(5) Bigger screens can tend to become a distraction on a bridge.

---

17. The RCDS should always be able to display the raster chart data set in (a) only north-up orientation, (b) either north-up or course-up orientations, or (c) only course-up orientation.
[7.1]

	Total	M. M.	M. Ad.	Carto.	Hydrog.	Other
a.	**5.4**	5.5	4.5	6.5	4.8	3.0
b.	**8.9**	8.8	9.0	8.6	9.0	10.0
c.	**2.7**	1.9	3.5	3.6	1.2	2.3

(1) ..or "chart-up" orientation as in ICW or small-craft charts that are not "north-up."
(3) Should flip between a) and b).
(3) Small-craft charts are skewed.
(5) Raster is limited to a single operation or its inverse - ECDIS allows any orientation.

---

18. The RCDS should indicate the orientation convention used on each display.
[7.1]

Total	M. M.	M. Ad.	Carto.	Hydrog.	Other
9.2	9.5	10.0	9.5	9.0	8.3

(1) Only if "course-up" is an option.
(5) [Use] a North Arrow.
(5) Should define [orientation convention].

---

19. The RCDS should provide for true motion mode in route monitoring, although other modes are permitted.
[7.2]

Total	M. M.	M. Ad.	Carto.	Hydrog.	Other
8.3	9.0	8.0	7.8	9.6	8.3

(1) I am not sure what this refers to. True vs. relative.
(1) For instance?
(5) Should define [true motion model].

---

20. The RCDS should indicate the mode of motion used on each display.
[7.2]

Total	M. M.	M. Ad.	Carto.	Hydrog.	Other
8.6	9.0	10.0	8.3	9.6	8.3

(1) Relative to what? ARPA targets.
(1) If others are permitted.
(3) It should be obvious.

---

21. When the RCDS is in true motion mode, reset and regeneration of the neighboring area should take place automatically at a distance from the border of the display determined by the mariner.
[7.3]

Total	M. M.	M. Ad.	Carto.	Hydrog.	Other
7.7	7.3	7.5	7.3	9.4	8.1

(1) With caution.
(3) In some situations this should be automatic.
(3) [I'm] not so sure the mariner should have complete control over this option.
(4) Or a default setting.

---

22. In RCDS, it should be possible to manually change the chart area and position of own ship relative to the center of the display. (a means to provide short look-ahead)
[7.4]

Total	M. M.	M. Ad.	Carto.	Hydrog.	Other
8.8	9.2	10.0	8.7	9.2	8.3

(3) (Possibly in a different view.)
(3) Possibly limit the short look-ahead.
(3) Nice feature.
(5) chart area: scale? Or display?

---

23. The RCDS should allow the mariner to select whether own ship is displayed as a symbol or true scale, based on mariner entered ship characteristics.
[8.3]

Total	M. M.	M. Ad.	Carto.	Hydrog.	Other
7.0	5.3	6.0	7.8	8.6	5.6

(5) True scale is very useful.

---

24. The RCDS should be capable of displaying information for route planning, supplementary navigation tasks and route monitoring, as well as mariner's entered notes, lines and designated areas.
[9.1, 10.3.5]

Total	M. M.	M. Ad.	Carto.	Hydrog.	Other
8.1	7.8	8.0	8.2	8.4	7.9

(3) Hot links from lat, long. to other charted features.
(5) Good, but not necessary.
(5) Especially true for river navigation.

---

25. The RCDS displayed information must be simultaneously visible to more than one observer at a distance of one meter, under normal day and night light conditions.
[9.4]

Total	M. M.	M. Ad.	Carto.	Hydrog.	Other
8.6	8.3	9.0	8.3	9.8	8.4

(1) Large bridge teams are a thing of the past.
(3) Can this be realistic on a 13" monitor?
(5) Very desirable.

---

26. The use of RCDS for route planning & monitoring should be simple and reliable.
[10.1]

Total	M. M.	M. Ad.	Carto.	Hydrog.	Other
9.3	8.8	10.0	9.4	9.8	8.6

(No corrections)

---

27. The RCDS should be ergonomic and user-friendly.
[10.2]

Total	M. M.	M. Ad.	Carto.	Hydrog.	Other
9.2	8.2	9.0	9.6	9.4	8.7

(5) Yes.

---

28. It should not be possible to remove information from the RCDS government hydrographic office's official raster chart data set, or its updates.
[3.5, 4.3]

Total	M. M.	M. Ad.	Carto.	Hydrog.	Other
8.8	8.3	9.0	9.4	8.4	7.9

(1) Local notices?
(3) Updates: yes (to change info); removal, no.
(3) How does this relate to question #30?
(3) Perhaps remove an information layer without display, but no deletion from the official data set.
(5) Would like to enter update, local information.
(5) It cannot be guaranteed that the user will apply the updates provided.

---

29. The RCDS must be capable of accepting official updates to the raster chart data set. These updates should be automatically applied to the previously resident official raster chart data set.
[4.5]

Total	M. M.	M. Ad.	Carto.	Hydrog.	Other
9.1	8.0	10.0	9.3	9.8	8.8

(1) The paper chart does not have an automatic update system. A great idea, but NOT necessary for equivalence to the paper chart!
(3) Automatically, or completely upon operator commencement?
(3) [The updates should be acceptable as either] raster or vector.
(5) There is no process that will "automatically" apply updates without manufacturers intervention.

---

30. The RCDS must be capable of accepting manual updates to the raster chart data set with simple means for verification prior to the final acceptance of the data. The manual updates should be distinguishable from the official raster chart data set and its official updates, and not affect display legibility.
[4.6]

Total	M. M.	M. Ad.	Carto.	Hydrog.	Other
7.6	7.7	9.0	7.9	7.4	6.7

(3) See #28. Making all changes stand out as changes would suffice for safety, legality.
(3) Absolutely not.
(3) Manual updates may require the deletion of an item. [Also, this conflicts with question #28.]
(3) Use a different color.
(5) Manual updates should not be allowed--only user "notes."

---

31. By whatever means the RCDS updates are received and processed, the implementation procedure should not interfere with the RCDS display in use.
[4.5]

Total	M. M.	M. Ad.	Carto.	Hydrog.	Other
8.4	7.0	9.0	9.4	9.4	6.3

(3) Display should indicate update data are available.
(3) Updates should be able to be applied to the RCDS [while the system is] in use without shutting down the system, and with the mariner's okay.
(3) Avoid clutter, separate displays for old vs. new stuff. Minimize confusion.
(5) Updates must be applied before use, not during.
(5) Not necessary.
(5) [Should not interfere] for very long--say 1 minute.

---

32. The RCDS must keep a time stamped log of updates.
[4.7]

Total	M. M.	M. Ad.	Carto.	Hydrog.	Other
8.9	7.0	9.0	9.8	8.8	8.4

(3) In underlying database with accountability checking.
(3) Legal issue? Can it tell automatic vs. manual?
(3) Important for USCG/NTSB accident investigations.
(5) Very important.
(5) Transaction log must be generated by the system--not entered by hand.
(5) Not necessary.

---

33. The RCDS should allow the mariner to review the log of updates to ascertain that the latest available updates have been incorporated in the raster chart data set.
[4.8]

Total	M. M.	M. Ad.	Carto.	Hydrog.	Other
9.2	8.2	10.0	9.7	9.2	8.6

(3) For consistency and integrity.

---

34. It should be possible for the mariner to mark out lines and areas on the RCDS display for the system to highlight and/or monitor relative to ships track.
[10.3.5]

Total	M. M.	M. Ad.	Carto.	Hydrog.	Other
7.7	8.4	9.0	7.5	9.0	6.3

(1) What does "mark out" mean? Delete? Unclear to me.
(3) I understand that this would function as an alarmable

---

35. The RCDS display should incorporate updates to the raster data set with no degradation of the information content in the update.
[3.8]

Total	M. M.	M. Ad.	Carto.	Hydrog.	Other
9.5	9.0	10.0	9.6	9.2	9.9

(2) There should be some receipt verification process, checksum, etc.
(3) Should be transparent except be marked as update information if called for in type of display.
(3) Should be transparent except be marked as update information if called for in type of display.
(3) (arrow drawn to question #30 with note:) Avoid the Las Vegas effect.
(5) ...and previous information content of proximal features.

---

36. The RCDS should provide a means of ensuring the raster chart data set and all of its updates are correctly loaded and accessible in the system.
[3.9]

Total	M. M.	M. Ad.	Carto.	Hydrog.	Other
9.6	9.0	10.0	9.7	9.8	9.9

(1) How do you define the "chart data set?" Is it all charts, all those on the CD, or all charts on a route?
(3) A foolproof system? [That] would be a first!
(5) (if not provided for in questions 30-33.)

---

37. The RCDS display should clearly distinguish the raster chart data set and its updates from other displayed information, such as mariner's notes, lines, and designated areas.
[3.10]

Total	M. M.	M. Ad.	Carto.	Hydrog.	Other
8.7	6.5	9.0	9.3	8.6	8.8

(3) For integrity: layer 1 - original, layer 2 - updates, layer 3 - local notes. Must be differentiated.
(5) Seems as though it should be a separate function to have to call up notes, lines, etc., different font or color code to identify.

---

38. The contents of RCDS raster chart data set with its updates should be adequate and up-to-date for the intended voyage, as required by V/20 of SOLAS.
[1.2]

Total	M. M.	M. Ad.	Carto.	Hydrog.	Other
9.8	10.0	10.0	9.6	9.8	10.0

(3) Temporal time stamp?

---

39. The RCDS MUST NOT provide a means to alter the contents of the raster chart data set.
[4.3]

Total	M. M.	M. Ad.	Carto.	Hydrog.	Other
8.3	8.2	9.5	8.3	8.4	7.7

(1) May want to elaborate on this.
(1) May add data but not alter or remove existing data!
(3) Tricky issue. How do you allow for manual updating from LNM? Manual updates only in vector overlay, not raster?
(3) See question #30.
(3) No editing capability, but multiple displays okay.
(3) Original [raster chart data set]?
(5) Otherwise integrity cannot be assured.

---

40. The largest scale raster chart data set available for the applicable area should always be used for all alarms or indications of crossing the mariner entered safety line and entering mariner highlighted areas.
[10.3]

Total	M. M.	M. Ad.	Carto.	Hydrog.	Other
7.9	5.5	9.0	8.5	8.8	7.3

(1) Again, not an equivalence issue!
(1) Confusing.
(2) ...and these designated areas should remain in memory and [be] applicable even when viewing at other scales.
(3) Didn't think there were RASTER ALARMS?
(5) But, alarm systems should not be limited to largest scale only.

41. Route planning with the RCDS should permit the use of both straight and curved segments. [10.3.1]

Total	M. M.	M. Ad.	Carto.	Hydrog.	Other
7.4	6.6	8.0	7.7	7.2	7.1

(1) [For] turns or Great Circle?

---

42. It should be possible to adjust a planned route by: adding and deleting waypoints, changing the position of a waypoint, and changing the order of the waypoints. [10.3.2]

Total	M. M.	M. Ad.	Carto.	Hydrog.	Other
8.9	8.0	9.0	8.9	9.4	9.1

(1) "changing the order of the waypoints" - Clarify...What I would like to see is alternate routes displayed both individually and sequentially.
(2) It should be possible to store previously used sailing routes for future reference and possible use.
(5) Needed.

---

43. It should be possible to plan an alternate route in addition to the selected route and the selected route should be clearly distinguishable from any alternate routes. [10.3.3]

Total	M. M.	M. Ad.	Carto.	Hydrog.	Other
8.2	6.5	8.0	8.6	9.2	8.1

(No comments)

---

44. The RCDS must provide an indicator if a planned route crosses a mariner-entered safety line. [10.3.5]

Total	M. M.	M. Ad.	Carto.	Hydrog.	Other
8.3	6.5	9.0	9.0	8.6	7.7

(1) Again--good idea--not an equivalency issue!
(1) Define "mariner-entered safety line."
(5) Responsibility of the mariner.

---

45. The RCDS must provide an indicator if a planned route crosses a boundary of a geographical area which the mariner has highlighted to be avoided.
[10.3.5]

Total	M. M.	M. Ad.	Carto.	Hydrog.	Other
8.6	6.8	9.0	9.1	9.0	8.3

(1) Would be important for avoiding areas where no research clearance has been granted.
(1) Again--good idea--not an equivalency issue!
(1) Sound? Light? Alarm?
(3) Again, didn't think raster trigger existed.
(3) Alarm!
(5) Responsibility of the mariner.
(5) Good to have, but not necessary.

---

46. The RCDS should provide the capability for the mariner to specify a limit of deviation from the planned route beyond which an alarm would sound.
[10.4.3]

Total	M. M.	M. Ad.	Carto.	Hydrog.	Other
8.2	6.3	8.5	8.7	8.6	8.1

(1) Again--good idea--not an equivalency issue!
(3) Make it a variable?
(3) Wasn't it indicated in the initial Q&A sheet that alarm capability wouldn't be available?
(5) Good, but not necessary.

---

47. The selected route, ship's position and alternate routes, if any, should appear whenever the display covers that area.
[10.4.1]

Total	M. M.	M. Ad.	Carto.	Hydrog.	Other
8.2	7.8	7.5	8.7	7.8	8.0

(1) What about actual track vs. DR?
(2) Mariner selected, I trust.
(3) Mariner's choice.
(5) Alternate routes should have to be called up & not display automatically.

---

48. The RCDS should be able to display an area where the ship does not appear, however the automated route monitoring functions should continue to function.
[10.4.2]

Total	M. M.	M. Ad.	Carto.	Hydrog.	Other
8.7	8.8	9.0	9.4	9.8	8.9

(3) Flexibility. To look elsewhere, ahead, other possible routes.
(5) Or should resume when the area containing the ship reappears.

49. It should be possible to return to the ship's position display from the non-ship display by a single operator action.
[10.4.2]

Total	M. M.	M. Ad.	Carto.	Hydrog.	Other
9.2	8.8	9.0	9.4	9.8	8.9

(3) Flexibility. To look elsewhere, ahead, other possible routes.

---

50. The RCDS should give an alarm if the ship will cross the mariner-entered safety line within a specified time set by the mariner.
[10.4.6]

Total	M. M.	M. Ad.	Carto.	Hydrog.	Other
7.9	6.0	9.0	7.8	9.6	8.3

(1) Again--good idea--not an equivalency issue!
(3) "?"
(3) [emphasis added]
(3) The time should be pre-set and immediate.

---

51. The RCDS should give an alarm if the ship will cross a geographical area highlighted by the mariner for avoidance.
[10.4.12]

Total	M. M.	M. Ad.	Carto.	Hydrog.	Other
8.7	7.0	9.0	9.0	9.4	8.6

(1) Again--good idea--not an equivalency issue!
(3) [emphasis added]

---

52. The RCDS should give a alarm when the specified limit of deviation from the planned route is exceeded.
[10.4.3]

Total	M. M.	M. Ad.	Carto.	Hydrog.	Other
8.3	6.5	9.0	8.6	9.2	8.6

(1) Again--good idea--not an equivalency issue!
(3) [emphasis added]

---

53. The RCDS should provide an indication when the input from the position-fixing system is lost.
[10.4.5]

Total	M. M.	M. Ad.	Carto.	Hydrog.	Other
9.5	8.3	10.0	9.6	10.0	10.0

(1) Again--good idea--not an equivalency issue!
(1) [emphasis added]
(2) [emphasis added]
(3) Backup from last position known?
(3) [emphasis added]
(4) [Must be an] active [indication].
(3) Yes!!
(5) Important.
(5) [emphasis added]

---

54. RCDS should display any alarm or indication passed to it from a position-fixing system.
[10.4.5]

Total	M. M.	M. Ad.	Carto.	Hydrog.	Other
8.9	7.6	10.0	9.2	9.0	8.9

(1) Again--good idea--not an equivalency issue!
(2) [emphasis added]
(3) [emphasis added]
(5) [emphasis added]

---

55. The RCDS should give an alarm if the ship, within a specified time or distance, will reach a designated point on the planned route.
[10.4.6]

Total	M. M.	M. Ad.	Carto.	Hydrog.	Other
6.8	6.0	8.0	6.5	8.2	6.8

(1) Again--good idea--not an equivalency issue!
(3) Depends upon the criticality of the point.
(3) Fine, why not. Lots of bells and whistles tagged to any fixed object or product space!
(3) Too many alarms may cause complacency.
(5) Not necessary.

---

56. The raster chart data set employed by the RCDS and the positioning system should be on the same geodetic datum. RCDS should give an alarm if they are not.
[10.4.7]

Total	M. M.	M. Ad.	Carto.	Hydrog.	Other
8.6	7.5	10.0	8.7	8.6	8.7

(1) Again--good idea--not an equivalency issue!
(1) What about projections?
(3) [emphasis added]
(3) Yes to same data set; no to alarm.
(5) How would it know?
(5) Good.

---

57. It should be possible to display alternative routes. The selected route should be clearly distinguishable from the other routes.
[10.4.8]

Total	M. M.	M. Ad.	Carto.	Hydrog.	Other
8.5	8.2	9.0	8.8	8.2	8.1

(3) Essentially the same as #43. If you can plan an alternate route, you surely should be able to display it.
(5) Yes! Definitely.

---

58. During the voyage, it should be possible for the mariner to modify the selected sailing route, or change to an alternative route.
[10.4.8]

Total	M. M.	M. Ad.	Carto.	Hydrog.	Other
9.2	9.7	9.0	8.9	9.6	9.4

(5) Necessary.

---

59. It should be possible for the RCDS to display: time labels along the ship's track--either manually or generated automatically (from 1 to 120 minute intervals).
[10.4.9.1]

Total	M. M.	M. Ad.	Carto.	Hydrog.	Other
7.9	7.8	8.0	7.8	8.6	7.8

(1) This should be [split into] two questions--manually and generated automatically.
(5) Good.

---

60 It should be possible to enter geographical co-ordinates of any position into the RCDS and have RCDS display that position on demand, or indicate that the geographical co-ordinates are not included on any to the raster chart data sets resident on the RCDS.
[10.4.10]

Total	M. M.	M. Ad.	Carto.	Hydrog.	Other
7.8	7.0	8.0	8.4	8.0	7.0

(1) Again--good idea--not an equivalency issue!

---

61. It should be possible to select any point (feature) on the RCDS display and read its geographical coordinates on demand.
[10.4.10]

Total	M. M.	M. Ad.	Carto.	Hydrog.	Other
8.7	6.7	8.0	9.4	8.6	8.6

(1) Again--good idea--not an equivalency issue!
(3) Position based on pixel size and resolution of the display.

---

62. It should be possible to adjust the ship's geographical position manually. This manual adjustment should be noted alpha-numerically on the screen, maintained until altered by the mariner, and automatically recorded.
[10.4.11]

Total	M. M.	M. Ad.	Carto.	Hydrog.	Other
6.7	7.3	8.5	6.8	6.2	5.7

(3) "??" Need additional understanding as to the situation that would cause the mariner to manually alter the ship's position.
(5) Legal question if accident.

---

63. The accuracy of all calculations such as course made good, time to way point, and speed over ground, performed by RCDS should be consistent with the accuracy of the raster chart data set.
[11.1]

Total	M. M.	M. Ad.	Carto.	Hydrog.	Other
8.8	9.0	8.5	9.0	8.0	9.0

(1) Meaningless to me.
(2) Do we mean accuracy (do we know the accuracy?), or do we really mean "scale?"
(3) [emphasis added]

---

64. On-display measurements of bearings and distances between features on the display, should have an accuracy no less than that afforded by the resolution of the display.
[11.2]

Total	M. M.	M. Ad.	Carto.	Hydrog.	Other
8.3	8.0	8.5	8.8	8.0	7.1

(1) [Between] 0.5 and 1.0 nautical mile should be adequate; greater resolutions can't be usually verified.
(3) "?"
(4) At least as good as paper chart.

---

65. RCDS should be provided with means for carrying out on-board tests of major functions either automatically or manually.
[13.1]

Total	M. M.	M. Ad.	Carto.	Hydrog.	Other
8.6	8.8	10.0	8.3	9.0	8.4

(1) Should be automatic self-tests.

---

66. In case of a failure during on-board tests, the RCDS should display information to indicate which module is at fault.
[13.1]

Total	M. M.	M. Ad.	Carto.	Hydrog.	Other
8.1	8.6	9.0	7.9	9.8	6.5

(5) Good.

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67. RCDS should provide a suitable alarm or indication of system malfunction.
[13.2]

Total	M. M.	M. Ad.	Carto.	Hydrog.	Other
9.3	10.0	10.0	8.9	10.0	9.0

(3) [Need] auto backup.
(5) [emphasis added]

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68. The RCDS should provide short-term power supply backup to maintain operation during temporary disruptions to ship power.
[15.1]

Total	M. M.	M. Ad.	Carto.	Hydrog.	Other
9.4	10.0	9.0	9.3	8.8	9.8

(4) Most bridge nav systems I'm familiar with already have power backups. This would be redundant (otherwise I would have given it a higher rating)
(5) Very much needed.

69. The RCDS may accept and display both radar image and ARPA information.
[6.3.1]

Total	M. M.	M. Ad.	Carto.	Hydrog.	Other
7.4	4.8	10.0	8.0	8.0	7.0

(1) Again--good idea--not an equivalency issue!
(5) Not necessary.

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70. If the radar image is added to the RCDS display, the radar image should account for the displacement between the positioning system antenna and the radar antenna as well as match the display in scale and in orientation.
[6.3.2]

Total	M. M.	M. Ad.	Carto.	Hydrog.	Other
8.3	5.5	9.0	9.1	9.0	8.2

(1) Again--good idea--not an equivalency issue!
(3) If it can be done.
(4) Antenna displacement error may be small compared to discrepancies due to chart projection vs. radar which is a planer view.
(5) Good for close quarters situations.
(5) Yes, but not likely.
(5) Have capability of input.
(5) At least two.
(5) should have the capability [available].

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71. It should be possible to remove the radar information from the RCDS display by a single operator action.
[6.3.5]

Total	M. M.	M. Ad.	Carto.	Hydrog.	Other
8.7	6.7	9.0	8.8	9.8	9.4

(1) Again--good idea--not an equivalency issue!
(5) Needed.

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72. It should be possible to enter the length, width, height, and draft of the vessel into the RCDS.
[-]

Total	M. M.	M. Ad.	Carto.	Hydrog.	Other
7.8	6.3	8.5	8.2	8.8	6.9

(1) Again--good idea--not an equivalency issue!
(3) Is draft applicable for an RCDS except as a visual reminder to look at sounding values?
(5) Necessary in some cases.

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73. It should be possible for the mariner to enter, verify, and accept all data necessary to establish times or distances associated with RCDS alarms and indications.
[-]

Total	M. M.	M. Ad.	Carto.	Hydrog.	Other
8.8	8.7	10.0	9.1	8.4	8.1

(3) Caution needed here.
(3) [emphasis added]

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74. [no question]

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75. The RCDS should be operated with inputs from two independent positioning systems.
[10.4.4]

Total	M. M.	M. Ad.	Carto.	Hydrog.	Other
7.3	5.8	8.0	7.6	7.0	7.7

(1) Again--good idea--not an equivalency issue!
(1) Mariner who only has one positioning system always knows where he is; mariner who has more than one never sure.
(3) GPS unreliable? Loran around for any length of time. Sat Nav?
(3) At least.
(3) At least 2 options--maybe 3.
